ROYAL ASTRONOMICAL SOCIETY.

Vol. XII. *February* 13, 1852. No. 4.

The Annual General Meeting of the Society, J. C. Adams, Esq., President, in the chair.

Rev. Thomas Allen Southwood, Cheltenham College, and John Dillwyn Llewelyn, Esq., Glamorganshire, were balloted for and duly elected Fellows of the Society.

Report of the Council to the Thirty-second Annual General Meeting.

The return of the period at which it is the duty of the Council to address their constituent body often suggests a few words on the history of the Society, and of the science which it is intended to promote. When the founders of our association circulated their first address, explanatory of their views and objects, they thought it desirable to make something like an apology for encumbering anything so perfect as astronomy with help. "It may be conceived by some," they said — and we know the figure to mean that some had so conceived — "that astronomy stands less in need of assistance of this kind than any other of the sciences; and that in the state of perfection which its physical theory has already reached, its ulterior progress may safely be trusted to individual zeal, and to the great national establishment exclusively appropriated to celestial observations." Perhaps our founders, at that time, were not fully aware that when theory treads on the heels of observation, it shows that observation has either relaxed its diligence in collecting, or neglected to make use of its stores; perhaps they could hardly guess that the unused records of the great national establishment could, by themselves, have been made to prove the latter; perhaps they would not have ventured to anticipate that the Society they were founding would, in thirty years, see such additions made to both theory and practice as would encourage their successors to affirm that progress could never end. But they had sufficient anticipation of the future to let no assertion of an existing finality disturb them in their course; and every succeeding year gives fresh proof of their sagacity. That which has just elapsed is no exception to the rule, either with reference to the science or our own Society; though, as to the latter, it has been saddened by the loss of two most efficient members of the actual Council.

The Report of the Auditors, subjoined, will show the state of the finances:—

RECEIPTS.

	£	s.	d.
Balance of last year's account	330	7	11
½ year's dividend on £2163 12*s.* 6*d.* 3½ per Cents	37	5	10
½ ditto on £2449 5*s.* 4*d.* ditto	38	12	10
1 ditto on £1150 Consols	33	10	0
On account of arrears of contributions	81	18	0
86 contributions (1851–52)	180	12	0
3 ditto (1852–53)	6	6	0
10 compositions	210	0	0
25 admission fees	52	10	0
18 first year's contributions	34	13	0
Sale of Memoirs, &c.	55	15	8
	£1061	11	3

EXPENDITURE.

	£	s.	d.
Cash paid for investment of 7 compositions	147	0	0
George Barclay, for printing Memoirs, Vol. XIX.	127	15	2
Ditto ditto Vol. XX. and Monthly Notices	252	15	0
George Richardson, plasterer	10	14	0
J. Charlton, map case	9	10	0
J. W. Rumfitt, bookbinder	11	16	5
Taxes { 1 year's property tax 1 9 2			
Taxes { 1 year's assessed tax 6 9 5½			
	7	18	7
J. Williams, 1 year's salary as Assistant-secretary	100	0	0
Ditto commission on collecting £411 14*s.* 8*d.*	20	11	6
Charges on books, and carriage of parcels	6	7	11
Postage of letters and Monthly Notices	28	17	9
Porter's and charwoman's work	12	11	8
Tea, sugar, biscuits, &c. for evening meetings	13	13	0
Coals, candles, &c.	12	18	6
Sundry disbursements by the Treasurer	23	0	10
Balance in the hands of the Treasurer (Jan. 1852)	276	0	11
	£1061	11	3

Assets and present property of the Society:—

	£	s.	d.
Balance in the hands of the Treasurer	276	0	11
Due from Mr. Byng £22 6 0			
1 contribution of 7 years' standing 14 14 0			
1 ——— of 6 ditto 12 12 0			
4 ——— of 4 ditto 33 12 0			
4 ——— of 3 ditto 25 4 0			
15 ——— of 2 ditto 63 0 0			
23 ——— of 1 ditto 48 6 0			
	219	14	0
Due for publications of the Society	2	16	0

£1150 3 per Cent Consols.
£2449 5*s.* 4*d.* 3½ per Cent Annuities.
Unsold publications of the Society.
Various astronomical instruments, books, prints, &c.

Stock of volumes of the *Memoirs* :—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	45	V.	186	XIII.	274
I. Part 2	90	VI.	204	XIV.	460
II. Part 1	106	VII.	229	XV.	246
II. Part 2	72	VIII.	215	XVI.	270
III. Part 1	135	IX.	222	XVII.	265
III. Part 2	155	X.	235	XVIII.	282
IV. Part 1	157	XI.	245	XIX.	301
IV. Part 2	172	XII.	256	XX.	342

Progress and present state of the Society :—

	Compounders.	Annual Contributors.	Non-residents.	Patroness, and Honorary.	Total Fellows.	Associates.	Grand Total.
February 1851	125	161	66	6	358	60	418
Since elected	6	26	...	...	32	...	32
Deceased	—1	—4	—1	...	—6	—2	—8
Removals	4	—4	...	...	...	...	...
Resigned	...	—1	...	...	—1	...	—1
February 1852	134	178	65	6	383	58	441

The instruments belonging to the Society are now distributed as follows :—

The *Harrison* clock,
The *Owen* portable circle,
The *Owen* portable quadruple sextant,
The *Beaufoy* circle,
The *Beaufoy* transit,
The *Herschelian* 7-foot reflector,
The *Greig* universal instrument,
The *Smeaton* equatoreal,
The *Cavendish* apparatus,
The 7-foot Gregorian reflecting telescope (late Mr. Shearman's),
The Universal quadrant by Abraham Sharp,
The Variation transit (late Mr. Shearman's),
The *Fuller* theodolite,

are in the apartments of the Society.

The Brass quadrant, said to have been *Lacaille's*, is in the apartments of the Royal Society.

The Standard scale is in the charge of the Astronomer Royal, with the consent of the Council, to be employed in the construction of a new Standard Measure, under the direction of the Standard Committee.

The remaining instruments are lent, during the pleasure of the Council, to the several parties undermentioned, viz. :

The *Beaufoy* clock,
The two invariable pendulums, } to the Royal Society.
The *Wollaston* telescope, to the representatives of the late Professor Schumacher.
The other *Beaufoy* clock, to Mr. J. Drew.
The *Lee* circle, to Captain Blackwood.

The twentieth volume of the *Memoirs*, and the accompanying and supplementary eleventh volume of *Monthly Notices* for the Session 1850–51, have been published some time. In the former are several papers from Mr. Maclear, which show how zealously and usefully he discharges his duty as Her Majesty's Astronomer at the Cape of Good Hope. These, with the exception of the paper on the "Parallax of α *Centauri*," are printed at the expense of the Government, as coming properly under the head of Cape Observations.

Mr. Maclear's account of the continuation of the measurement of an arc of the meridian at the Cape to stations where local disturbances of attraction are little probable, is very interesting, and we believe that the results of this most arduous undertaking will bear a comparison with those of a similar nature under more favoured circumstances. But without some very considerable additional aid in computation, it will not be possible to prepare and publish this standard work in any reasonable time. The great expense is already incurred, but no available results can be presented, until the whole of the observations have been carefully, and completely, and systematically reduced. This arc of the meridian is, we believe, the only arc which has yet been measured in the southern hemisphere with first-rate apparatus, and Mr. Maclear, with prudent foresight, laid at the same time the basis for a trigonometrical survey of a large part of the colony.

In the Catalogue published by the British Association, under the direction of Mr. Baily, the materials for the places of the southern stars were found to be very defective; perhaps the only Catalogue to be then thoroughly depended on was Mr. Johnson's Catalogue of Stars observed at St. Helena. Mr. Maclear has undertaken to revise all those stars in the B. A. C. which have not

been sufficiently determined already; and in the volume of our *Memoirs* just published, there is a large list of rectifications, which a paper since received has considerably increased. In many cases, from an examination of the original data of Lacaille's *Cœlum Australe*, Mr. Maclear has been able to suggest the cause of error. This interesting inquiry has been, perhaps, pushed by Mr. Maclear to its full limit, considering the data on which Lacaille's catalogue is founded, and the manner of its formation; but a Cape observer would be an astronomer of a very different temperament from Mr. Maclear, if he did not think the correction of a slip of Lacaille's pen a sufficient reward for a serious and laborious investigation.

The determination of the parallax of *α Centauri* is a good specimen of resolute and intelligent research, well rewarded by the importance of its results. Mr. Henderson first called attention to the probably large parallax of this star, and Mr. Maclear has determined the amount at two different epochs, the latter of which is recorded in our last volume. On the evidence of this memoir it seems that the parallax of this fine double star is 0″·92, with great certainty. The observations, so far as we can see, admit of no constant error, nor of any error obeying a law: that casual error is sufficiently eliminated by the immense mass of observations, is evident from the small amount of probable error. Perhaps it might be worth while to ascertain the non-influence of refraction upon the observations, by comparing *α Centauri* with stars in the same parallel; but no conceivable error in the refraction could much affect Mr. Maclear's results. From the mode of observation, temperature can have little influence on the instrument or its microscopes. Mr. Maclear proposes to continue these researches with the circle in the same way as he has hitherto done, and also to employ his new equatoreal in measuring the relative positions of the component stars. The difference of declination determined with the equatoreal will give an additional check on the circle observations.

Mr. Maclear's numerous friends will be glad to hear that he has, to a considerable degree, recovered from the harassing and distressing service of conducting the measurement of the arc of meridian, and that his able and intelligent assistant, Mr. Mann, is also restored to health. But we would venture to remark that an addition to the ordinary computing force of his establishment would not only tend to preserve these zealous men from manifest risk of overstraining themselves, but would very much increase their utility by enabling them to devote their whole attention to worthy objects.

During the past year, the astronomical world has been interested by the successful attempt of Foucault to prove, mechanically, the rotation of the earth by means of the vibrations of a very long pendulum. The general solution of this problem was simultaneously given by several eminent mathematicians, and the velocity of rotation at any point of the earth's surface was theoretically deduced by them. But, amongst the practical difficulties in making

the experiment successfully, the greatest was to get rid of the rapid motion of the apse, which invariably takes place when a pendulum subject to any disturbance describes a very long ellipse. With whatever care the pendulum was suspended and set swinging, it was generally impossible to make it describe an exact plane and to prevent all disturbance of its point of suspension; and the consequence was, that the apsidal motion was in many instances so confounded with the apparent azimuthal rotation of the plane of vibration, that the most contradictory results were produced. The Astronomer Royal, to whom we are indebted for so many valuable papers on similar subjects, has treated the subject with all the generality that it admits of, and has succeeded in giving simple rules, by which the effect of the apsidal motion arising from faulty suspension or from elliptic path may be got rid of.

The Council also beg to call particular attention to an elaborate discussion of the elements of the planet *Mars*, by Mr. H. Breen, of the Royal Observatory, Greenwich, who is well known as an able and zealous computer. The ancient Greenwich planetary observations, which have been now for some years rendered available by the labours of the Astronomer Royal, have been made excellent use of by Mr. Breen, not only with regard to *Mars*, but *Venus* also; and the elements of the orbits of both these planets are determined for definite intervals of four years from the epoch of Bradley's observations to nearly the present time. In the case of *Mars*, the whole of this work is due to Mr. Breen; in the case of *Venus*, he completed the determination of the elements from the ancient observations which had been begun by his father.

The *Monthly Notices* have been conducted on the same plan as in former years, with perhaps a still greater tendency to include in them such papers of moderate length as do not require illustrations or tabular matter. This increases our printing expenses somewhat and our postage a good deal. Perhaps, as long as the funds of the Society allow us to be liberal, there is no need to be very anxious to reduce the cost, if we thereby reduce the quantity of information or the circle of its extension. But it may not be amiss to suggest a plan by which, if it met general consent, a good deal of trouble, and perhaps some expense, might be saved. The *Astronomische Nachrichten* publishes almost all our observations and more than all our ephemerides, earlier and more punctually than we can do, at shorter intervals, and throughout the year. By the present arrangement, which it only depends on the members to keep up, this unrivalled periodical is sent regularly by post, without any extra charge beyond the very moderate subscription. If we suppressed that portion of the *Notices* which is made up of observations and ephemerides, and which would find their proper place in the *Nachrichten*, we should save a good deal of expense, and, at times, useless printing, besides giving our assistance to the journal which has done, and is doing, more for astronomy than can be accomplished by any other means.

As the dispute between Denmark and the Duchies seems happily to have terminated, we may hope that the King will resume the position held by his predecessors as an especial patron of our science. It is, however, the duty of the Council to impress upon its members, and, if necessary, through their means upon the public, that the *Astronomische Nachrichten* is now an astronomical requisite, and must be supported by those who wish well to the progress of astronomy.

Amongst the contributions to our *Monthly Notices* during the present year, not the least remarkable is a paper by the Astronomer Royal on the relative stability of the altazimuth instrument at Greenwich. Soon after its erection it was found that the steadiness of the azimuthal zero was not so satisfactory as the massive construction of the instrument, and the undoubted excellence of all the mechanical arrangements, had led him to expect. Suspicion first fell naturally upon the instrument itself, and means were devised for preventing any reaction of the centre-work in the rotation of the instrument. This proving of no avail, a collimating mark was set up, which, by the steadiness of the readings in azimuth, showed that the fault did not rest exclusively in any want of steadiness of the azimuthal circle of the altazimuth instrument. The only remaining supposition was evidently that the time transmitted from the transit instrument of Troughton (then in use) was incorrect, either from faulty determinations of its errors of adjustments, or from faulty comparisons of clocks, or from both these circumstances combined. After having obtained a long series of readings of the collimator and simultaneous determinations of azimuthal zero by observations of stars, the Astronomer Royal devised a method for applying the calculus of probabilities to determine the relative proportions of the three classes of independent errors with which he had to deal, viz. 1st. Instability of the azimuthal circle; 2dly. Instability of the collimator; 3dly. Uncertainty in the time transmitted from the transit instrument. Independently of the abstract value of the solution of a problem of this class, the results which have been deduced have a very great interest, as affecting the standard observations of the present time. It was found, in fact, that the chief part of the errors in question were entailed by the transmission of time from the transit instrument, the error due to the assumed instability of the azimuthal instrument being only one-seventh part of that due to the faulty transmission of time. To the full belief in this fact by the astronomers of Greenwich generally, even before the accurate solution of the problem, we owe, amongst other reasons, the great transit circle, which has occupied the places of both the transit instrument and mural circle, and the assurance that similar principles with regard to massiveness and firmness of construction must ultimately be adopted in the construction of all first-class instruments.

During the past summer, amongst other astronomers and sci-

entific gentlemen attracted to our shores by the Great Exhibition, we have received a visit from Mr. G. P. Bond, the zealous and able observer at the Harvard Observatory, Cambridge, Massachussetts. While here, he exhibited at the Society's apartments the galvanic apparatus for observing transits, which has been for some time in use at that Observatory. By his kindness and anxiety to give an accurate knowledge of the construction and mode of action of the apparatus, the members of this Society have had the best possible opportunity for learning the details of its management, and of the success which had already attended its operations in America. Since it is probable that this mode of registration of transits will ultimately supersede all others, we cannot too fully acknowledge the courtesy of Mr. Bond individually, and of the Directors of his Observatory, who authorised his mission, for their courtesy and desire to make us as soon as possible participate in this the greatest improvement, probably, that has been made during the present age in the means for making and multiplying accurate observations, and for determining with absolute accuracy the longitudes of all stations, however distant, which can be connected by wires.

The want of some fixed standards for the better determination of the magnitudes of stars has for a long time been sensibly felt by astronomers, and it is, therefore, gratifying to find that considerable attention has been recently paid to the subject. Independently of the researches of Sir J. Herschel and Mr. Johnson, we would call attention to a remarkable paper by Mr. Dawes, in the recently published volume of our *Notices*, as containing the practical details of a method of photometric comparison which has the merit of being very simple and easily applicable by every one provided with a telescope. The principle is the same as that in other methods which have occasionally been proposed; that is, it proposes to diminish the light of all stars compared, so as to reduce them to some common standard of brightness. Mr. Dawes proposes to diminish the aperture of the telescope employed till the star under comparison becomes barely, but steadily, visible, and to take as the standard aperture that which just secures visibility to the average of several of Argelander's stars of the sixth magnitude. Assuming then the obvious principle that if two stars, as viewed through a telescope, appear equally bright, the illuminating powers employed (that is, the areas of the portions of the object-glass employed) must be inversely proportional to their magnitude or real brightness; it is easy to calculate the areas of the portions that must be left exposed to render *just* visible the stars arranged according to a definite scale of magnitudes, and to provide a series of pasteboard rings that can be readily numbered and applied, by means of the formula given in the paper. Such a method in the hands of so vigorous and accurate an observer as Mr. Dawes cannot fail to lay the foundation for a correct and general survey of the heavens with regard to star-magnitudes, and to take from the science of astronomy

the arbitrary character which is attached at present to this branch of it.

Amongst foreign astronomers who have from time to time contributed to our *Notices*, none have been more constant or zealous in adding to our resources by observation or computation than Mr. Rümker of Hamburg. As increasing years and decline of health have, at length, compelled him to relax in his efforts for the advancement of astronomical science, and to contemplate retirement from his professional employments, we feel bound to express at this time our obligations to him for his incessant labours in the service of astronomy generally, and for his constant goodwill and services to this Society for a long series of years. Mr. Rümker has been chiefly known to us for some years past for the active part which he has taken in the observations of the small planets and comets, which have been discovered in such rapid succession. His observations have been usually amongst the first contributions to the history of these minute and faint bodies, and he has not unfrequently been the first to make use of his own observations in the construction of orbits and ephemerides for the ease of other observers. In addition to these casual works, of a sufficiently laborious character, when added to his daily duties as Master of the Nautical School at Hamburg, the great work of Mr. Rümker is yet to be mentioned. In the year 1843 appeared the first part of a projected catalogue of 12,000 fixed stars, made chiefly for the purpose of filling up the gaps which remain in *Bessel's Zones* and the *Histoire Céleste*. This work is now nearly, if not quite, completed. The half of the remaining or fourth part, containing the stars lying between 18^h and 21^h of right ascension, appeared in 1849; and Mr. Rümker will, in all human probability, before entirely laying aside his astronomical duties, have the satisfaction of presenting the remaining portion to astronomers. In the present state of science, large catalogues of stars, especially of stars not very far removed from the zodiacal limits, are especially valuable to aid in the discovery of more of those small bodies, of which so many have been added to our planetary list; and such a work as Mr. Rümker's, executed by the sacrifice of all the leisure left to him by his strictly professional engagements, is a gratifying tribute to the scientific energy of the present age. We have only mentioned those works of Mr. Rümker which have been prominently brought before the notice of this Society; and it would be, perhaps, going beyond our province to offer any eulogium on his labours in the service of nautical astronomy, or in the more direct path of his professional duty. We have before us more than enough to justify this tribute to his unwearied industry, to his zeal and love for our science, and to the ability which has rendered his efforts useful to astronomy. The meeting will, without doubt, join the Council in wishing that the evening of Mr. Rümker's life may be spent in the happy consciousness of having materially added to the perfection and the enlargement of the noblest of the physical sciences, and that his son may continue

to tread in his footsteps, and to develope still further the energy and talent which he has already shown, and which promise to make him a worthy successor to his father.

The Council cannot, without the deepest regret, advert to the retirement of Mr. Riddle from their body, after an uninterrupted service of twenty-seven years. During this long period, no member of the body has been more regular in his attendance, or more willing to place the leisure left by an arduous and fatiguing avocation at the disposal of the Society. To this it is due that, on the many occasions on which Mr. Riddle has urged the length of his service as a reason for giving place to others, the Council have always felt that services of such value could not be dispensed with for such a reason. But increasing age and health worn out by long exertion have made it necessary to yield at last. We are happy to add that the Government has allowed Mr. Riddle to retire from his office on terms honourable to all; so that, if rest of mind and body should, as all will sincerely hope they may, restore him to full health, we may yet feel the benefit of his renewed co-operation.

The Council have awarded the gold medal to C. A. F. Peters, for his papers on the Parallax of the Fixed Stars, and on the Constant of Nutation. The President will announce the special grounds of this award in the usual manner.

The Society has to regret the loss, by death, of two Associates, M. Goldschmidt and M. Boguslawski; of two members of the Council, Mr. Galloway and Mr. Woollgar; and of the following fellows:—Mr. Peter Clare, Mr. Hill, Mr. Lockhart,* Rev. J. Maher, Lord Melville, and Sir W. Morrison.

Palm Henry Lewis Pruss von Boguslawski was born at Magdeburg, September 7, 1789. His father, who was captain in the regiment, "Prince Louis," and afterwards in the regiment, "Courbière," died in 1802. Boguslawski received his early education at the Cathedral School of Magdeburg, and was under the paternal care of Prince Louis, from his father's death up to the death of the Prince in the fatal fight of Saalfeld. Another true and tried literary friend of his father's, the Consistory Counsellor Dr. Benedict Funk, who for many years was rector of the Cathedral Gymnasium at Magdeburg, took a lively interest in the young Boguslawski, and especially contributed to his love for astronomy and mathematics, by introducing him to the personal acquaintance of Lorenz and Bode. Boguslawski's desire to give himself entirely to science was interrupted by the events of 1806, and altogether stopped by the surrender of Magdeburg to the French. He

* The recency of the death of Mr. Lockhart obliges the Council to postpone further notice till next year.

entered the army, as a volunteer, in the beginning of the campaign which was decided by the battles of Jena and Auerstadt. After this he lived with his friends and relations in the Mark till 1809, occupying himself chiefly with astronomical and mathematical pursuits. He then entered the artillery, newly organised by Prince Augustus of Prussia in the Silesian provinces. In 1811 and 1812, which he passed in the Royal School of Berlin, he improved his friendship with Bode, and under Bode's guidance completed several astronomical essays, which are inserted in the *Berlin Ephemeris for* 1815 *and* 1816. In 1812, Boguslawski joined the garrison of Glatz as lieutenant, but was soon called into more active service. In 1813, August 30, he was wounded and made prisoner at Culm, but escaped to Prague, where he was confined four months in consequence of his wounds. In the February of 1815 he joined the allied army in its French campaign. Soon after his return to Glatz, he was transferred to Breslau as First Lieutenant. In 1817, he quitted the army and became possessed of the knightly estate of Gross-Raarke, near Breslau, when he married Augusta Wolff, the daughter of an iron-master at Breslau, who survives her husband. By this marriage he leaves two sons and three daughters. From the date of his marriage up to 1830, Boguslawski was occupied with the management of his domestic affairs, though he still found time for astronomy, having, fortunately, recovered from a weakness in the eyes brought on by his compaigns. As his occupation did not turn out well, he sold his estate and returned to Breslau, where he was for a year employed in the civil service, in the division of Communal property. In the meantime, on the death of Professor Jungnitz, the direction of the Breslau Observatory was given to Dr. Scholtz, who, as he already held another professorship, advised that the practical working of the Observatory should be consigned to a special curator, and recommended Boguslawski as proper for that duty. The date of his appointment as Conservator of the Observatory is December 2, 1831. From this time his scientific activity had a wider sphere and became more generally known. The discovery of a comet in 1835, April 20, obtained for him the first of the gold medals awarded by the King of Denmark for the discovery of telescopic comets, and the Lalande prize of the Académie. The philosophical faculty of Jena forwarded to him in the same year the diploma of Doctor, *honoris causâ;* and he was admitted *ad eundem* by the Faculty of Breslau. In the same year he was the first, or one of the first, to rediscover Halley's Comet. In 1836, Boguslawski was nominated Professor Extraordinary of Astronomy in the University of Breslau.

He was elected an associate of many foreign scientific societies; of the Royal Astronomical Society, of the Academy of Cracow, of the Geographical Society of Berlin, of the Societies for Natural and Physical Research of Emden, Frankfort, Hamburg, Jassy, Marburg, &c. At Breslau, for many years in succession, he discharged the duties of secretary for the geographical section of the Silesian Society for Patriotic Cultivation. His unwearied

activity brought on an organic disease in the throat, which medical skill was unable to cure, and he died 1851, June 5, lamented by all those who had the opportunity of appreciating his scientific zeal and amiable disposition.

Professor Boguslawski paid great attention to practical astronomy, and recommended the use of a "difference-micrometer," of his own invention, which is described in vol. xv. of our *Memoirs*. He afterwards contrived a universal instrument, which was intended to embrace all the qualities required in an astronomical instrument. A model of this is to be seen at the Breslau Observatory, and it has been described in the *Transactions* of the Isis Society of Aix-la-Chapelle, and in the Arts Section of the Silesian Society (*Rep. Brit. Assoc.*, 1845, p. 6.) In 1845 he visited England, and was present at the meeting of the British Association at Cambridge, where he read a notice on the great comet of 1843, and on comets generally. Besides these purely astronomical subjects, Boguslawski paid unremitting attention to the phenomena of falling stars, so that Breslau became the central point for that class of observation. The Breslau Observatory being well furnished with magnetic instruments, chiefly on the recommendation of Humboldt and of the British Association, an extensive and valuable series of observations was carried on from 1836 to 1851 under Boguslawski's direction. Since 1846 the professor published yearly, under the title of *Uranus*, a synchronical ephemeris of phenomena, visible on the horizon of Breslau, which was found of great use to amateurs. In the number for 1851 are found the last labours of the professor upon the great solar eclipse, which he did not live to complete.

Charles Wolfgang Benjamin Goldschmidt was born at Brunswick, 1807, August 4, and received his early education in the schools of that town, principally at the *Collegium Carolinum*. In 1828 he went to Göttingen, where he commenced and prosecuted his studies in mathematics and astronomy with great success. In 1831 he gained the student's prize medal (which is given by the Philosophical Faculty), for the solution of a problem in the calculus of variations. In 1831, Nov. 5, he graduated as doctor in philosophy, and engaged himself as a teacher of mathematics at Hoffwyl in Switzerland, the well-known educational establishment of M. Fellenberg. Goldschmidt soon returned to Göttingen, where, in 1833, he acquired the "*veniam docendi*;" and on Harding's decease in 1834, was engaged as assistant at the Royal Observatory. In 1844, without changing his relation to the Observatory, he was appointed Professor Extraordinary in the Philosophical Faculty. Dr. Goldschmidt died 1851, Feb. 15, prematurely and very unexpectedly, from disease occasioned by some irregularity in the functions of the heart. This produced, from time to time, during the last few years, symptoms of cerebral congestion, apparently of an epileptic character.

In his university lectures, Professor Goldschmidt treated upon finite and infinite analysis, the calculus of probabilities, theoretical

astronomy, mathematical geography, and terrestrial magnetism. As assistant at the Observatory, he became associated with the illustrious Gauss in many of his scientific inquiries which relate to astronomy and magnetism.

His principal works are :—

Determinatio Superficiei minimæ rotatione curvæ, data duo puncta jungentis, circa datum axem ortæ. Göttingen, 1834. This is his prize memoir.

Treatise on Analytical Optics, by Professor J. C. Edward Schmidt, edited after the author's death by Benjamin Goldschmidt. Göttingen, 1834.

Atlas des Erdmagnetismus, according to the results of Professor Gauss' theory, by W. Weber and Goldschmidt. Leipzig, 1840.

Researches on the Magnetic Declination at Göttingen, published in the Göttingen *Studien*, 1845.

Many of Professor Goldschmidt's observations and calculations relating to magnetism and astronomy are published in the *Resultate* of the Magnetic Association of Göttingen, and in Schumacher's *Astronomische Nachrichten.*

In 1834 Goldschmidt embraced the Lutheran confession, and then prefixed the surnames of Charles Wolfgang to his original name of Benjamin. Some confusion might arise if this use of two surnames by the same person were not kept in mind.

John Webb Woollgar was born November 7, 1795, at Lewes, Sussex, and was educated at the grammar-school of that town, but his varied store of information was chiefly due to his own industry, and to the careful instruction of his parents, who were well qualified for the task of directing and assisting his inquiries. Being prevented by delicate health from joining in usual boyish sports, he sought for recreation in the study of mathematics and astronomy ; and at the age of thirteen received a prize from the conductors of the *Juvenile Miscellany.* In trigonometry, which at that time did not form part of the ordinary school education, he was wholly self-taught.

He was destined for the practice of medicine, but the state of his health led to the abandonment of this intention, and he was articled to a solicitor in his native place, where he subsequently practised for many years. At an early age he evinced his love for literature in the office of secretary to the Lewes Literary Society, mainly founded by his father, and was elected an honorary member in acknowledgment of his services. Subsequently, in conjunction with a few other gentlemen, he established a Mechanics' Institute. These useful institutions were then little known or appreciated ; and he had to contend with some opposition and much indifference, which, however, served only in this, as in other instances, to increase his energy and perseverance. In 1822 he married, and passed the next eighteen years in the practice of his profession, but during the whole of this period devoted a considerable portion of his time

to his favourite pursuits. He entertained a great desire to bring the slide-rule nearer to perfection, and to reduce it to general use: he was very conversant with the history and use of this neglected instrument, and proposed more than one extension and modification of it. His close application to this subject in the year 1826 nearly cost him his life, and he was compelled, by the order of his medical attendant, to relinquish his labours.

In addition to those above mentioned, other local institutions and societies received much of his attention. Amongst these may be particularised the savings' bank, and the Sussex Provident Society. The affairs of the latter, in its numerous branches, became much embarrassed, but were wound up by Mr. Woollgar, and his colleague Mr. Godlee, in a manner so satisfactory to the guarantors, that both were presented with a handsome testimonial. He gave also much consideration to the savings' banks' system generally, and the nature and operation of friendly societies; and on the former subject read a paper in 1844 at the York meeting of the British Association for the Advancement of Science. Of the great services rendered by these societies to the scientific world, he ever expressed himself deeply sensible; and through life embraced every opportunity of attending their meetings. The Society for the Diffusion of Useful Knowledge testified their sense of his zeal in the cause of literature and science by appointing him to their local committee.

In 1840 he retired from the practice of the law, and the pursuits which till then had occupied his leisure hours now became the business of his life. At the expiration of two years he was placed in the commission of the peace for the county, and was most active and efficient in the discharge of his duties. In 1850 he was elected on the Council of the Royal Astronomical Society, and immediately undertook to superintend the publication of a new catalogue of the Society's library. Before its completion, his health declined so perceptibly as to oblige him to intermit his labours; he, however, persevered, and had the gratification of completing his task, in the manner which the Council acknowledged in the last annual Report. This was his last work. His disorder (of the heart) increased rapidly; and in full consciousness of, and preparation for, his approaching end, he was removed on the 6th March, 1851.

Though no work of sufficient size to attract general notice emanated from his pen, it would be tedious to enumerate the pamphlets, tables, calculations, &c., on various subjects, by the publication of which he endeavoured to diffuse knowledge and to aid the social progress of man.

Mr. Woollgar's distance of residence from London, and consequent inability to be a regular attendant at our meetings, caused him to be comparatively little known to the generality of our Fellows, except as a gentleman who took much interest in astronomy. Partly from this, and partly from the feeling that it is expecting too much from non-residents in London, unless they are officially connected with astronomical institutions, to serve on

the Council, it was not until within two years of his death that Mr. Woollgar was placed on the list. In this capacity, the zeal, good temper, and business-like qualities which he displayed were such as to make it a matter of much regret that he had not been better known at an earlier period.

It would be an injustice to close this memoir without allusion to the kind offices rendered by Mr. Woollgar to private friends; it will suffice to say that many sought his counsel and assistance, and that he was ever ready to bestow both with judgment and kind feeling.

Thomas Galloway was born in the upper ward of Lanarkshire, February 26, 1796. His father and maternal grandfather had long been tenants of Symington farm and mill, in the parish of that name. His paternal grandfather had been noted in his district as a mechanical engineer, and in that character had been retained for some years at St. Petersburg by the Earl of Hyndford, the British ambassador. The subject of this memoir received his first education in the parish schools of Symington and Biggar, and the academy of New Lanark. His studies were mostly classical, and he obtained distinction in them. He entered the University of Edinburgh in 1812, and studied there eight sessions. In 1811 some French officers, prisoners of war, came to reside in his native district on parole. Of some of these he made the acquaintance, and finding two of them able mathematicians and willing to give instruction, he became their pupil during the months when he was not at college. Any one who knew his age could observe that he had a familiarity with, and taste for, the French school of mathematicians, such as few acquired in his day from the mathematical education given in either the Scotch or English universities. But, according to his own account, though studying mathematics with pleasure, he never felt that interest in them which determined his career until he came under the instructions of Professor Wallace in the winter of 1815–16. A prize proposed for the solution of certain problems was gained by Mr. Galloway, who thereupon became a favourite pupil of the professor. Mr. Wallace assisted him in finding employment as a teacher and as an editor. He remained at Edinburgh until 1823, took the degree of Master of Arts, and qualified himself for the church, for which he had been originally intended; but he did not apply for a preacher's license, feeling rather inclined towards the life of a teacher of science.

In 1823 he was appointed one of the teachers of mathematics at the Royal Military College, Sandhurst. In 1831 he married the eldest daughter of his old teacher, Professor Wallace. In November 1832, he became a candidate for the chair of Natural Philosophy in the University of Edinburgh, vacant by the death of Sir John Leslie, and was one of three who were selected for final consideration out of a numerous list of candidates. At the end of the following year he was likely to have been selected as professor of

astronomy in the same university; but at this time he obtained the situation of registrar (as the actuary is there called) of the Amicable Life Assurance Office, the oldest in London. In this post he continued till his death, which took place from spasms of the heart, after many months' illness, on November 1, 1851.

Mr. Galloway's publications, though numerous, were mostly, from their nature, anonymous. Perhaps the earliest was the article Pendulum, in Brewster's *Cyclopædia*. In the *Encyclopædia Britannica*, he wrote the articles Astronomy, Balance, Calendar, Chronology, Comet, Figure of the Earth,* Precession of the Equinoxes, Probability. This last article has been separately published. It gives from Laplace and Poisson a complete account of the use of the theory of probability in observation. In Leybourn's *Repository* he wrote two articles on Porisms, and a biography of Sir John Leslie. He also contributed to the *Edinburgh Review*, in which his first article was a review of the *Memoirs* of our Society (No. 101); and to the *Foreign Quarterly Review*. Many reviews were also contributed by him to the *Philosophical Magazine*. Many of these reviews are historical essays of considerable research; the account of M. Pontécoulant's work, from the *Foreign Quarterly*, was translated into French in the *Révue Encyclopédique*, tom. 46. In the *Philosophical Transactions*, part i. for 1847, he wrote an elaborate memoir on the proper motion of the solar system, derived from the proper motions of the southern stars, which was honoured by the award of the Royal medal. This memoir is an extensive calculation of probable errors; and in vol. xv. of our own *Transactions* is another research of the same kind relative to the great survey in England. To this application of the theory of probabilities his mind peculiarly inclined; and the nature of an actuary's business has a tendency to encourage attention to that subject in general. He also wrote a paper on our knowledge of shooting stars, which was printed in vol. v. of the *Monthly Notices*. In the conduct of the business of the Royal Society, he was for many years an active participator; and the loss of those nameless services, on which the progress of a society so much depends, will be felt by our neighbours as well as by us.

Mr. Galloway was elected to the Council of this Society in 1834, immediately after his permanent settlement in London. He served the office of secretary, or of foreign secretary, in six different years; and was second to none who have filled those offices in the attention which he devoted to their duties. Every matter of business was with him a matter of anxiety; and he never felt sure that it was done, or done well enough. In the conduct of our affairs he was, indeed, among our most valuable members. His habits were those of a man of business, and he had, in a remarkable degree, that power over details which enables its possessor to keep all his object in view, and to attain it all. These excellent and

* His latest writing on this subject, the article "Trigonometrical Survey," in the *Penny Cyclopædia*, is a clear and brief summary of its methods and history.

useful qualities, combined with his strict attention to enforce economy, were not only most beneficially felt at the time, but have had a very perceptible influence since. On the very last occasion on which he spoke of the Society, in a conversation with the writer of this memoir, a few days before his death, he expressed an earnest desire that neither strength nor length of eulogy should be inserted in this Report. The writer, who promised that his request should be complied with, conceives that the simplest truth, though expressed in the spirit of the promise, must defeat the intention with which it was exacted. Mr. Galloway was a mathematician to whom no terms of less force than sound and learned can be applied. He was one of the few to whom the history of exact science and its applications was familiar, especially that of the seventeenth and eighteenth centuries. He was, so far as he chose to be, a collector of books; and though his library was not large, yet no astronomical collection of equal value and rarity, for its size, has been for many years offered for sale. The collection of Kepler's works is unique, as to its completeness in any one library, being under nineteen titles. With his books he was familiar; and in his writings, so far as they are historical, it is plainly seen that he had consulted originals. The love of accuracy was a strong feature in his character. He was not, probably from want of continued opportunity, given to astronomical observation; but he had an interest in the details of it, particularly in those which relate to geodesy, and in its history, which is very seldom felt except by those whose time is or has been largely devoted to it. It was this which brought him into contact with our Society, and made him one of its steadiest supporters; and if, in deference with his dying wish, little is said of his attainments or his publications, the Council may at least express their conviction of the eminent value of his services to us, and their persuasion that his name will be long remembered among us.

The late Peter Clare, Esq., was born in Manchester, some time in the early part of the year 1781, but the exact date of his birth is not known. While quite a youth he was accustomed to assist his father, who was in the habit of giving occasional lectures on electricity and kindred subjects, illustrated by experiments. The son, in consequence of his early habits and inquiries, was frequently admitted to the meetings of the Literary and Philosophical Society of Manchester, while he was yet ineligible for membership on account of his youth. His modesty held him back till the year 1810, when he was regularly proposed and elected an ordinary member. Subsequently he was made a member of the Council. In 1821 he became secretary, which post he retained till 1842, when he was elected a vice-president of the society. He held this office during several of the latter years of his life, and discharged its duties with unremitting attention, till disabled by his last fatal illness. Mr. Clare was not a frequent contributor to the memoirs of any of the literary or scientific societies with which he was connected; but he was an ever active friend to all engaged in such

pursuits, was thoroughly imbued with a taste for philosophical investigation, and acknowledged by all who knew him to be a man of very varied and extensive information.

He was for many years the intimate friend and almost constant companion of Manchester's brightest ornament, the late celebrated Dr. John Dalton, and was appointed one of the doctor's executors. He was equally known as a zealous and untiring member of the Anti-slavery committee, and was on several deputations to the Government during the agitation of that great question.

While in health Mr. Clare was uniformly cheerful. In the social circle he was always entertaining, and not unfrequently facetious, having a large fund of humorous anecdotes and amusing narratives at command. His company was often sought and always acceptable. Like his illustrious friend Dr. Dalton, he was brought up a Quaker. To that denomination he adhered through life; but he never unseasonably obtruded his religious opinions upon others.

Mr. Clare was never married, and has left very few near relations to mourn his loss. His last illness was long, but not painful. The disease under which he finally sank is believed to have been an affection of the heart. He died on Monday, Nov. 24, 1851, in the seventy-first year of his age, and was interred on the following Sunday in the Friends' burying-ground, Mount Street, Manchester. His remains were followed to their last resting-place, by a numerous body of his own denomination, by the President, the Council, and other members of the Literary and Philosophical Society, and a large concourse of spectators.

Peter Clare was in every sense a truly respectable and much respected man, an ornament to the connexion in which he moved, and his loss is sincerely regretted by a wide circle of acquaintances and friends.

Thomas Wright Hill, a member of our Society almost from its first institution, died at Bruce Terrace, Tottenham, on the 13th of last June, in the eighty-ninth year of his age.

He was born at Kidderminster in April 1763. Even in early childhood he exhibited a strong taste for study and an insatiable appetite for books, of which he devoured all that came in his way. Amongst others of his great favourites were the *Pilgrim's Progress*, *Paradise Lost*, and Stackhouse's *History of the Bible*, in two volumes folio.

He was educated at the Grammar School of his native town, where, as usual, mathematics formed no part of the course; in common arithmetic he received instruction elsewhere. As his introduction to the study of geometry was a little curious, it is described as nearly as possible in his own words:—

"A worthy man, a friend of my father's, was appointed joint trustee with him to administer the estate of a common acquaintance who had lately died. The latter being a man of somewhat secluded habits and of a studious and philosophic turn of mind, some of the

good people of Kidderminster set him down as in league with the Evil One. This gentleman, knowing that I was fond of books and of study, had bequeathed to me two volumes, which, however, my father's friend and coadjutor very strongly recommended him to burn, without allowing me even to see them, as they bore a suspicious appearance, and came from a dangerous quarter. My father, who was somewhat less credulous than his neighbours, said, 'Oh, let the boy have them;' whereupon were put into my hands —a *Manual of Geography* and a copy of Euclid's *Elements*."

On the latter work he immediately fastened with all the delight and energy of youthful enthusiasm; and, mastering its contents, proceeded, unassisted, to algebra and the higher mathematics, especially those portions connected with astronomy, to the study of which his attention had been attracted by a lecture from James Ferguson, which it was his good fortune to attend, and which excited in him so great a love for the science, that it always remained his favourite pursuit.

On this subject, in after life, he delivered many lectures as a fellow of the Philosophical Institution of Birmingham, doing besides as much in the way of observation and calculation as his close occupation and limited means would allow; also making it a subject of school instruction, and drawing up monthly reports upon the aspect of the heavens, which were read and explained to his pupils at Hazelwood School, near Birmingham, and in later years to the pupils of Bruce Castle, Tottenham.

In the year 1835, on his retirement from active duty as an instructor, this predilection was remembered by his former pupils; and the testimonial selected by them was a large refracting telescope by Tulley, with an inscription "indicative of their veneration for his unaffected simplicity of character, and their high respect for his abilities as an instructor and his virtues as a man."

As late as October 1847, in his eighty-fifth year, he repaired with his telescope to Willingdon, near the coast of Sussex, for the purpose of observing the great eclipse of the sun, an opportunity to which he had looked forward for years, but in which he was unhappily disappointed by the cloudy state of the weather.

Even to within a month or two of his death he was occupied in framing a system of nomenclature for the stars; his object being that the name of every star should indicate approximately its declination and right ascension.

Though on many of the various subjects to which at different times he devoted his attention he could never be prevailed upon to prepare any work for the press, or even to throw the results of his investigations and reflections into a complete form, he would occasionally commit his thoughts to writing on detached points.

About ten years ago, however, he constructed, with considerable labour, a set of tables for facilitating the formation of maps on the stereographic projection, for the use of his pupils; as also a set of tables of binarian logarithms.

About fifty years ago he devised a system of short-hand writing,

which by various changes from time to time, almost to the end of his life, he at length reduced to a complete philosophical alphabet, without depriving it of its stenographic character. He has left behind him no small amount of result from his oral instruction and conversation. Much originality of thought, fertility of illustration, the observation of a long life, and the stores of a very retentive memory, rendered them attractive in a high degree. It was particularly interesting to hear him describe as matters of actual recollection events which the present generation regards as long ago consigned to the province of history. He had been familiarly acquainted with men who were enrolled for the defence of Government against the rebellion of 1745. He remembered the imprisonment of Wilkes, and of course all the great events of the American War and the French Revolution; and in dwelling upon these he generally reproduced in a racy manner the popular opinions and speculations of the respective periods.

His vivacity and love of employment continued to be marked traits in his character to within even a few weeks of his death; nor did his fondness for young persons or their attachment to him ever suffer material abatement. Long after the period of his release from his professional duties he continued to teach as an amateur; until, at the age of fourscore, by the partial failure of both sight and hearing, this practice became painfully laborious. Still his activity in pursuit of science was unabated, as in 1845, in his eighty-third year, he read at the meeting of the British Association at Cambridge a paper explanatory of a new system of arithmetical notation, in which the names of the numbers were made by virtue of arithmetical significancy given to the vowels and diphthongs to indicate their precise meaning by their structure.

His closing years he always spoke of as the happiest period of his life. Possessed of a competency according to his very moderate desires, never at a loss for occupation,

> "Studious of laborious ease
> Nor slothful,"

encompassed by his family, and seeing in the decided success and acknowledged usefulness of his sons, much more than enough to satisfy all that he had ever known of ambition; looking back with frequently expressed gratification and thankfulness on the continued course of moral and material improvement presented to him throughout his lengthened acquaintance with human affairs; his taste for literature unabated, and his relish of life almost as keen as ever, he, nevertheless, met death with the most unruffled calmness and profound resignation, full of gratitude for the past and hope for the future.

The celebrated establishment of Hazelwood, removed to Bruce Castle in 1827, with which Mr. Hill's name is much connected, and in which he gave his personal assistance, was founded, in 1819, jointly by himself and his sons, most of whom took a share in its management. The success of these gentlemen not only in educa-

tion, but in public business, is a testimony to the talent, judgment, and goodness of their common parent, which renders all other testimony superfluous. It is not usual to enumerate the sons of a deceased fellow, but in the present case he made them, and they have made themselves, a necessary part of any obituary account of him. Mr. Matthew Hill, commissioner in bankruptcy for the Bristol district, recorder of Birmingham, and late member for Hull—Mr. Edward Hill, known as the inventor of the envelope-machine, and inspector of postage-stamps — Mr. Rowland Hill, whose services as secretary to the South Australian Commission, in the foundation of that colony, must be mentioned, and whose career, as the reformer of the post-office, and the originator of the uniform penny rate, needs no mention at all—Mr. Arthur Hill, whose life has been devoted to the cause of education, in the well-known institutions above mentioned — and Mr. Frederic Hill, many years inspector of prisons, and now assistant-secretary to the Postmaster-general—all bear the testimony of their own reputation to that of their father. That father was, indeed, most fortunate, not only in the distinction gained by his sons, but in the length of life which enabled him to see the full success of their career, and to know that his share in it was, we almost venture to say, as fully appreciated by the public as it is gratefully acknowledged by themselves.

Lord Melville, the only son of Henry first Viscount Melville and Baron Duneira, was born on the 14th of March, 1771, and was educated in the High School of Edinburgh, where he generally held the third place in the rector's class, then taught by the learned Dr. Adam. The powerful influence of his father opened the path to political employment; and in the year 1802 he was returned to the House of Commons as member for the county of Edinburgh. His conduct was generally considered judicious and sound, although he does not appear to have taken any prominent share in public business, till the question of his father's impeachment in 1805 drew him frequently into debate. He successively became President of the Board of Control, and chief Secretary of Ireland; but the sudden death of his father, in May 1811, unexpectedly called him to the House of Peers.

On the formation of the Earl of Liverpool's Ministry in 1812, Lord Melville became First Lord of the Admiralty, with a seat in the Cabinet; and he continued to discharge the duties of that highly responsible office for fifteen years. He retired from office on the accession of Mr. Canning; but resumed his place at the head of the Admiralty when the Duke of Wellington came into power in January 1828, when he remained in office until the dissolution of the Ministry in November 1830. That event closed his official career, though he still took an interest in public affairs, and was of essential service in the discussion or settlement of several questions of importance to Scotland. At length he was attacked by bronchitis at the beginning of last June, which quickly assumed an alarming shape, and in ten days carried him off in his eightieth

year. He died at Melville Castle, leaving a family of four sons and two daughters.

Major-General Sir William Morison, K.C.B. and M.P., who died on the 15th of May, 1851, was one of the many able officers whom the East India Company's service has produced. He went to India as a cadet in 1800. From his outset in life he applied his faculties to military science, in which his attainments were such as to place him on a level with men of celebrity in the armies of Europe.

So early as 1809 he filled the office of secretary to the Military Board at Madras. At the end of 1810 he was selected by Sir George Barlow, the governor of Madras, as the most competent person to form a commissariat establishment, then new to India. In addition to these laborious duties, he undertook the superintendence of the geographical and statistical survey of the Madras territory in the years 1811 and 1812. In this occupation, so congenial to his taste and acquirements, he took much delight, and acquitted himself greatly to the public advantage.

Colonel Morison was in the field as commissary-general throughout the military operations of the Mahratta war in 1817 and 1818, and was present at the battle of Mahidpore, in which he had an opportunity of exercising his talents as an artillery officer. After having been laboriously employed for fifteen years in the formation and direction of the Madras commissariat, he was transferred, by Sir Thomas Monro, to the diplomatic department, as Resident at the Court of Travancore. He was subsequently deputed by Lord William Bentinck, the Governor-general, in conjunction with Mr. J. M. Macleod, to administer the government of Mysore. In both stations he manifested the same capacity for business and devoted regard for the interests intrusted to him as had marked his previous career.

On the change in the constitution of the Indian Government, which took place in 1834, he was the first military officer selected for a seat in the Supreme Council of India. He filled that high position for five years.

During Lord Auckland's protracted absences from the seat of Government, the still more important and elevated offices of President of the Council of India and Deputy-governor of Bengal devolved upon him. In them he bore his faculties with so much prudence and judgment as to gain general approbation and good will. He returned to England in 1840, after forty years of active service in the East, and soon after attained the rank of major-general.

For above nine years he represented his native county, Clackmannan, in Parliament, and gave a steady support to the Liberal party. He occupied himself with the study of mathematical and physical science, and to the close of his life took a lively interest in certain improvements in gunnery, and small arms of his own invention, by which he believed that the national defence might be

materially promoted. Besides our own, Sir William Morison belonged to the Royal Society and to the Royal Asiatic Society.

For his military services he was made a Companion of the Bath in 1821, and, on the extension of that order, the dignity of a Civil Knight Commander was conferred upon him. Sir William Morison's disposition was remarkably benevolent and sociable, his heart warm and kind, and he has left many attached friends to lament his loss.

The greatly increased number of small planets, all subject to perturbations of great magnitude, and all moving in orbits of such inclination and ellipticity that it is extremely difficult to reduce their perturbations to a tabular form, has led M. Encke to examine whether it is not possible to effect the special numerical calculation of the perturbations by a process easier than that commonly employed. It is known that, in the usual method, the theory commences with the measure of disturbing forces in the directions of three rectangular co-ordinates; but the subjects of the special calculation in every instance are the perturbations of the elements of the planet's orbit; and when these perturbations are found and are applied to the elements existing at the beginning of the period of calculation, the planet's heliocentric place, and finally its rectangular co-ordinates, are computed for exhibition of the geocentric place. It occurred to M. Encke that the perturbations might be so computed as to exhibit *immediately* the changes in the values of the rectangular co-ordinates. If ξ, η, ζ, are put for those changes, then the equations upon which the determination of ξ, η, ζ, depends, are three simultaneous linear differential equations of the second order, $\frac{d^2\xi}{dt^2}$ being expressed by means of ξ, η, ζ (affected with co-efficients depending on the body's position with respect to the sun), and of the disturbing forces; and similarly for η and ζ. Now M. Encke has shown that, when the disturbing forces are computed for equidistant intervals, the process of double summation (upon which the double integration of $\frac{d^2\xi}{dt^2}$ may be made to depend) can be effected without sensible error, by introducing on the right side of the equation, step by step, very approximate values of ξ, η, ζ, for each successive interval, inferred from those which are computed for the preceding intervals. And M. Encke has shown, by actual calculation, that the results thus obtained do accurately agree with those obtained by the usual method; whereas, in his estimation, the labour of computation is reduced to less than one-half. This process appears likely to be of very great importance; most useful, without doubt, for the case for which it was invented, but likely also to be extremely useful in other numerical equations depending on physical investigations which lead to impracticable differential equations.

It is well known to persons engaged in the conduct of an active

observatory, especially where there are several assistants employed in the observation of transits, that there is no greater source of annoyance and uncertainty than what is usually called the *personal equation* in the observation of transits. And this is the more annoying, because there has been reason to think that between the same individuals the amount of the personal equation is not invariable, although the circumstances upon which its value depends are not well understood. We, therefore, attach considerable importance to an invention of Mr. Thomas Jones (formerly of Charing Cross, now of Rupert Street), expressly designed for the measure of this personal equation between two observers at any given time. It consists of a trunk tube, to be inserted in the eyepiece-socket of the transit, from which trunk there branch forth two eye-tubes, inclined with each other and with the trunk at angles of about 120°, one eye-tube for each observer. The pencil of light from the object is received upon a reflecting prism, by the edge of which the pencil is divided into equal parts, and by the surfaces of which the two halves of the pencil are transmitted up the two eye-tubes. And, when the adjustments are correct, the two observers see the object and the wires which it transits with perfect distinctness; they listen to the beats of the same clock; but they record their independent observations each in his own book. It would appear that here there can be no source of uncertainty, except in some cause of constant error peculiar to each eye-piece; and the effects of such a constant error are eliminated by reversing the observers with respect to the eye-tubes. An instrument on this construction has been introduced at the Greenwich Observatory, but has not been in use long enough to furnish positive results: it appears, however, likely to give great information on personal equation and all its modifications.

The improvements made from time to time, in those contrivances of civilisation or practical science, which are intended, in the first instance, for the convenience of ordinary or commercial life, render it advantageous and even necessary for the superintendents of astronomical institutions occasionally to examine how far it may be desirable to depart from ancient practical arrangements and to adopt new ones. Thus it has become impossible to overlook the advantages which may arise to pure astronomy (in the communication of observations), to geodesy (in the determination of longitudes), and to society in general (in the dissemination of accurate time), from a galvanic connexion of our national observatory with the great system of telegraphs throughout this kingdom. Within no long time, two events have occurred which tend greatly to facilitate this connexion and to increase its possible advantages. The first is, the establishment of a line of telegraph along the North Kent Railway, which passes within little more than a mile of the Greenwich Observatory. The second is, the successful establishment of the submarine telegraph, which gives the power of extending a connexion once made with the telegraph of the South-

Eastern Railway to France, and to almost every part of Europe. It is, therefore, with great satisfaction we announce that, on the representation of the Astronomer Royal, the Lords Commissioners of the Admiralty have sanctioned the galvanic connexion of the Royal Observatory with the North Kent Railway; and that measures are actually in progress, at the present time, for making this connexion. The wires will be carried underground across Greenwich Park and Blackheath to the Lewisham station, thence they will be conducted along the line of railway to the London bridge terminus, and there facilities will be given for the connexion of these wires with the Dover wires (by which the communication with the Continent will be made), and with the wires of the Electric Telegraph Company (by which communication will be made with the British observatories, and also with stations and public clocks, to which it is desirable to transmit signals of accurate Greenwich time). It is impossible to speak too highly of the liberality which has been displayed by the corporate bodies (the South-Eastern Railway Company and the Electric Telegraph Company), whose assistance was requisite for carrying out this project. MM. Arago and Babinet, and the members of the Bureau des Longitudes and the Institut, have shown the greatest interest in the completion of the connexion between Paris and Greenwich; and already a plan of observations has been in part concerted; to be directed in the first instance to the determination of the difference of longitude of the two observatories.

The new transit-circle of the Royal Observatory has been so repeatedly brought before the notice of the Society that it appears wrong to occupy their time with any detailed allusion to it at present. Still it appears proper to state that, after more than a year's experience (during which period this instrument has borne the entire charge of the meridional observations), there remains no doubt in the mind either of the Astronomer Royal or of the astronomers more immediately engaged in making and reducing the observations, that no other instrument with which they are acquainted can be compared with this for the steadiness and accuracy of adjustments and for the accuracy of results. It is unnecessary to allude to its great optical power, as the securing of this was in fact the first condition which required the construction of a new instrument on a novel plan.

The reflex zenith tube of the Royal Observatory was brought into use for the observations of γ *Draconis*, in the autumn of last year; and the observations, in consequence, have for the most part been made by daylight. This circumstance makes it difficult at present to state precisely the success of the construction. Several observations have been made, apparently of the most accurate kind; several have failed, the star not being visible. It is at present doubtful whether this arises from the tremor of the quicksilver (the pencil of light being in every case reflected from the surface of quicksilver), or from any other cause. It seems not improbable

that it may be found necessary to change the site of the instrument for one less affected by external disturbances.

During the last year the Radcliffe Trustees have increased the personal establishment of their Observatory by another assistant. Mr. Pogson has been appointed, whose name is well known to the Society. The Trustees have also sanctioned the employment of a computer. With this additional help Mr. Johnson hopes to be able to continue the meridian observations as heretofore, and to devote his own attention to the heliometer.

Little has been done with the latter instrument since the last Report, all the force of the establishment having been required to complete the circumpolar catalogue. The observations for this work may now be considered finished, and much has been done in arranging them to form a catalogue. This task has been consigned to Mr. Luff of Oxford, who is well qualified for it from his long familiarity with the Radcliffe Observations.

The next work to which Mr. Johnson proposes to apply the meridian instruments of this Observatory, is the revision of Piazzi's Catalogue as far as 110° of north polar distance. Stars south of that limit he proposes to leave to observatories better situated for observing them.

At Cambridge, Professor Challis is proceeding on the plan mentioned in our last Report, and is advancing in the publication of past observations. The meridian observations of 1846 are nearly printed, but vol. xvii. of the *Cambridge Observations* will not appear for a considerable time, as it is intended to include those of 1847 and perhaps of 1848. Changes are making in the apparatus of the Northumberland equatoreal, by which it is hoped to measure differences of right ascension (the clock carrying the instrument), yet more satisfactorily than hitherto. It is worthy of note that Faye's comet, on its first return in 1850, was observed at Cambridge nearly five weeks before it was seen at any other observatory, and the observations were continued till March 4 of last year. These observations are valuable, both for their extent in time, and also because the number of observations of this comet elsewhere, during the return in question, was not considerable. Great credit is deservedly given by the Observatory Syndicate to MM. Breen and Todd, the assistants at the observatory, for the manner in which these observations were secured under circumstances of unusual difficulty.

The effective advance of a practical and working observatory with a limited staff, is rather to be judged of by the calculations and printing, than by the number of observations obtained; and, in this point of view, it is gratifying to hear that the printing of another volume has just been concluded at Edinburgh, containing the calculated observations made there from 1844–1848; and further,

that the calculations for 1849, 1850, and 1851, are so far advanced, that the good effect of the solid, unadjustable Y bearings, and other improvements applied to the transit instrument, can now be spoken of with certainty. The fluctuations of the axis in azimuth, which used to amount to above the large quantity of a second of time, and that with a degree of suddenness and capriciousness which defied calculation, are now reduced to within $\frac{1}{4}$ of the former amount in quantity, while there is even a greater improvement in the manner. The changes are much slower and more regular than before, and are such as may not improbably be owing to differences of expansion in the stone composing the piers: they can, too, be effectually checked by the increased means now at command for examining, under all circumstances, the position of the instrument.

In having thus passed beyond the period of his late lamented predecessor's term of office, in the calculation and printing of the observations in the old-established form, Professor Piazzi Smyth has by no means forgotten the importance of publishing a resumé of the whole of Professor Henderson's work, more especially of condensing all the separate annual lists of stars into one general catalogue. But while this would prove a long work, with his time so much occupied at present by the lectureship attached to the office; and while it was manifestly of great importance, also, to bring up the calculations, and all the book-keeping of the stars to the present time, so as to be more free from actual work, and for making those observations which are now expected from Edinburgh,—yet, as the subject of procuring a second assistant for the establishment has been taken up by the Board of Visitors, he trusts that the commencement of the general catalogue has only been deferred a short time, and that, when begun, it will be quickly carried through.

At the observatory of Durham, Mr. Carrington has been engaged during the past year on the small planets and comets with the equatoreal: the observations have appeared in our *Notices*. An interruption of seven weeks occurred in the spring, in consequence of an attack of inflammation of the eye, induced by over-exertion of the retina; and during the greater part of July, Mr. Carrington was absent in Sweden, for the purpose of observing the eclipse of the sun: with those exceptions the small planets have been kept constantly in view. No change of instruments has taken place. Mr. Carrington has resigned the charge of that observatory, and will leave Durham in April next. It is to be hoped that an observer so zealous, intelligent, and methodical, will not be lost to astronomy.

Of the Liverpool observatory nothing new need be said; it maintains its reputation as the most trustworthy authority for *extra-meridional* observations, for *immediate* use. The excellence of his equatoreal enables Mr. Hartnup to compare all his objects with one or more perfectly well-determined stars, so that he obtains at *once* what an observer less completely equipped (that is, almost *every other observer*) may wait months to obtain. The reader of

the *Monthly Notices*, who can translate the data before him, has only to run his eye over the Liverpool observations, to feel convinced that what is here stated is a simple fact. Besides the care of testing and rating chronometers, which must in time have a most beneficial influence on navigation, though its progress is slow, Mr. Hartnup has lately been charged with the duty of taking very extended meteorological observations, at the request of the registrar-general, of which a specimen has been sent to us. We are rejoiced to find researches and observations of so useful a nature in such good hands; but we trust that Mr. Hartnup's patrons will not forget that there are limits to what a man can do, and that, after having gained the applause of the astronomical world for the liberality and judgment with which they planned and furnished their observatory, and after the striking success by which it has been attended, it would be bad economy to divert the principal attention of their astronomer from astronomy. With a little additional assistance, the Liverpool observatory will satisfy both objects perfectly: but the purposes for which the observatory was founded are still far the most important in a scientific point of view to which it can be applied.

An account of the operations at Mr. Cooper's observatory at Markree Castle, for the past year, was given in the December *Notice:* the catalogue of 14,888 stars, near the ecliptic, has been printed at the expense of the Government, on the recommendation of the Royal Society. Copies of this valuable work have been presented to astronomers with great liberality, and it will be particularly acceptable to those who are searching for fresh members of our system. This is the primary object of the catalogue. Another object which Mr. Cooper had in view, was the obtaining "an increased number of points from whence, by ocular triangulation, stars to the 12th magnitude inclusive might be, with sufficient accuracy, interpolated in maps prepared for the purpose."

The large equatoreal at Markree (25 feet focal length, and 14 inches aperture), fitted with a square-bar micrometer of Mr. Graham's contrivance, and an eye-piece magnifying about 80 times, has been used for these researches. The probable errors are about $0^{s}.3$ in R.A., and $4''$ in Declination. This is more than sufficient, and the convenience of the apparatus may be judged of by this: on each of two nights more than 500 stars were determined. The observations were made by Mr. Cooper and Mr. Graham; the mode of registering and reducing the observations is very clearly set forth in the preface to the catalogue. The charts in progress are on a linear scale of four times the Berlin maps. The magnitudes are readily distinguished by the mode of figuring adopted by Mr. Graham.

Though the matter is not yet arrived at maturity the Council cannot deny themselves the pleasure of recording a munificent proposal on the part of one of our Fellows, Mr. Henry Lawson, of Bath. This gentleman has offered to give his astronomical and

meteorological instruments to any individual or body of men, who will produce a sum of money sufficient to found an observatory, and to endow a resident observer with not less than 200*l.* a-year; and he has further offered to contribute one thousand guineas towards the necessary fund. The corporation of Nottingham has resolved to attempt the fulfilment of the condition, and a public meeting was held in that town on the 13th of January, at which a thousand pounds was subscribed. On the 26th it was reported that 2100*l.* had been obtained.* The sum required is estimated at 10,000*l.*; and the Council trust that it will be speedily raised, and that the institution will have an effect upon the promotion of astronomy, worthy of the high motives of its originator and benefactor.

There is not much to be said with respect to the standard yard in addition to what was stated in the last Annual Report. During the preceding summer, Mr. Sheepshanks' eyes were so weak, that he found it imprudent to attempt any measures. This would have induced him to resign his commission, if it had been easy to supply his place. It was the difficulty of finding a trustworthy person to undertake a laborious, dirty, uninteresting, and unpaid duty, which induced Mr. Sheepshanks to volunteer his services at first; and this difficulty, so far as he knows, is as great as ever. But in addition to this consideration, the course of the experiments has shown, that, next to good faith, the *identity* of the observer is the most important requisite; and that a large mass of good observations must be rejected, if a new observer were introduced, or else a discrepancy would probably be introduced of a sensible amount. Since that time, however, a considerable number of bars has been compared by Mr. Sheepshanks and by Mr. W. Simms, Jun., *with the heads of the micrometers turned the same way*. The measured length, therefore, is the *difference* of two readings, and, consequently, if an observer bisected all divisions alike, the *measures* should agree; of course, the *comparisons* should agree in every position of the micrometer heads. The measures do *not* agree, and, by a piece of ill luck, the bar adopted as the term of comparison, Bronze 28, is one about which the observers seem to differ most. The extreme difference between the results of the two observers, with respect to any bar, when the comparisons are made with Bronze 28, is very nearly one division of the micrometer, or 0·000036 inches. As this difference is made up of four bisections, it seems not unlikely that the observers might differ more than 0·00001 inch in a bisection, *i. e.* after allowing for the tendency to too *full*, or too *short*, a bisection, which disappears in a *measure*. The probable error of a set of 80 measures made by Mr. Sheepshanks, or of 20 measures by Mr. W. Simms, Jun., is scarcely more than $\frac{1}{8}$ or $\frac{1}{10}$ of the difference which is thus actually found to exist between their results, in extreme cases.

* At the time of printing this report, the sum raised amounts to 2630*l.*, not including Mr. Lawson's proposed donation.

The foregoing statement seems to show that the accuracy to be attained by a measure defined by lines or dots, or by a *divided scale*, is much less than was supposed: it shows, besides, the propriety, where great exactness is required, of performing the operation of measurement, as much as possible, by the same person, if indeed the *same* person continues to preserve his *identity* as an *observer*.

All the bronze bars, or, as they are called, "Baily's metal," would have been measured and defined by this time, but for a second attack of weakness in the eyes of the experimenter. Subject to the doubt and uncertainty mentioned above, there are no known difficulties in the execution of the rest of the task; and it is hoped that the observations, which have been resumed, may be speedily brought to a conclusion, so far at least as the present observer is concerned.

An account was given in the November *Notice* of this session of the mode in which the thermometers, used in the standard measures, were graduated. Temperature has never caused the slightest difficulty with respect to the measurement of the bars, though there is reason to suspect that the micrometers, or the screws which adjust the trough, may waver a little. The effect on the results would not however be sensible.

The year 1851 has witnessed the discovery of two new planets, belonging to the extraordinary group between *Mars* and *Jupiter*, which now numbers fifteen members. The first was found by Mr. Hind, at Mr. Bishop's Observatory, on the 19th of May, and four days later by Dr. de Gasparis, at the Royal Observatory, Naples. It resembled a star of the ninth magnitude, with a bluish light and some degree of nebulosity round it, under the most favourable glimpses on very clear nights. The planet received the name *Irene* on the suggestion of Sir John Herschel. It was observed at Washington, U.S., until the end of October, and the elements have been pretty exactly determined by several German astronomers. The period of revolution is 1515 days.

The second planet was detected by Dr. de Gasparis on the night of July 29th, in the course of his zone observations commenced with an especial view to the discovery of new planets. It was described as a fine star of the ninth magnitude; but owing to the lowness of its position (being near the ecliptic in 18^h R.A.) it was not so generally observed during its first apparition as some of the other newly discovered bodies. Dr. Gasparis called his planet *Eunomia*; the period of revolution is 1574 days, or about two months longer than that of *Irene*.

During the past year we have to record the reappearance of Encke's periodical comet and also the discovery of three new ones. The first was detected on the 27th of June by our associate Dr. d'Arrest, who speedily ascertained that no parabolic orbit will represent the observations, but that the comet is describing an elliptic orbit with a revolution of only six years. It was always

faint, and was observed with difficulty till the beginning of October. It has been conjectured that this may be the same comet that was observed in the summer of the year 1819, for which Prof. Encke calculated an ellipse.

The second comet of 1851 was found at the Observatory of Baron Senftenberg, in Bohemia, on the 1st of August, by Mr. Brorsen. The parabola agrees very well with the observations, which were continued till November.

The third comet was also discovered by Mr. Brorsen on the evening of October 22d, when it presented a rather brilliant appearance with a double tail, the shorter branch turned towards the sun. It became faint, however, before the end of the month, and was seen with difficulty in the middle of November. There are no indications of ellipticity in the orbit. This is the fifth comet which has been found by Mr. Brorsen during the last six years.

One of the most remarkable discoveries recorded during our past session is that of a dark interior ring of *Saturn*, which was first *certainly* seen by Mr. Bond at Cambridge, Massachussetts, on November 15, 1850, though he had suspected it before. This ring was seen by Mr. Dawes on November 29, before he could have received any intimation of Mr. Bond's discovery, and some days later by Mr. Lassell, with Mr. Dawes' telescope, also before he knew that it had been seen elsewhere. The dark ring has since been seen by many observers; by Mr. Lassell with his reflector, and by Mr. Hartnup with his achromatic, by Mr. Hind, Mr. De la Rue, and Mr. Fletcher. Mr. Lassell has had a drawing on a considerable scale lithographed, and Mr. Dawes and Mr. De la Rue have presented very satisfactory drawings to the Society, which are now hung up in the apartments. It is rumoured that some scepticism has been shown on the continent with respect to the reality of Mr. Bond's discovery; but from the evidence before us its existence seems as *certain*, though not so *evident*, as that of the other rings. It would seem from Mr. Dawes' remarks rather surprising that the dark ring was not seen before, or at least that it had not been inferred from the appearances which were seen.

Mr. Lassell has succeeded in bringing his reflecting telescope to so high a state of perfection that he scarcely hopes to make any important improvement in its defining powers. With this magnificent instrument he has been able to detect two interior satellites of *Uranus*, and to determine their periodic times with considerable certainty. These periodic times differ so much from the revolutions assigned by Sir W. Herschel to the two faint satellites of his discovery, that we must conclude them to be different bodies, if Sir William's determinations are deemed to rest upon satisfactory grounds. These objects are so very faint and minute that they can only be seen under favourable circumstances; but the series already observed by Mr. Lassell scarcely admit of any solution, but that

which he has arrived at, viz. that the periodic times are 2·5 and 4 days respectively.

Mr. Lassell has made a considerable set of observations of the brighter satellites of *Uranus*, those denoted by Sir William Herschel as II. and IV.; of the satellite of *Neptune;* and the fainter satellites of *Saturn.*

The Council allude to a publication which has recently appeared in private circulation, not only on account of its interest to Fellows of this Society, but because a reference to its astronomical observations may hereafter be useful to those who would think such a work unlikely to contain them. Towards the end of last year, Captain Smyth published, in a handsome quarto volume,* a description and history of the mansion at Hartwell, the residence of our late Treasurer, Dr. Lee, to whom the Society is in so many ways a debtor. This volume contains, among many other things, a full description of the Hartwell Observatory, the meridional observations made by the late Mr. Epps, those of double stars made by Capt. Smyth himself, with an historical account of *γ Virginis*, and the appearance of Encke's comet in 1848. Dr. Lee has thus connected the history of his own family with that of astronomy; and the Council hope that, at a distant period, his successors will feel the force of his example, and the wisdom of his course.

Very recently, another volume has been published more exclusively devoted to astronomy, by our Treasurer, Mr. Bishop. It is a detail of the observations made at the South Villa Observatory from its establishment in 1839 to 1851, with such historical and descriptive additions as would naturally be looked for. It contains the valuable series of double-star observations made by Mr. Dawes, and continued by Mr. Hind, together with the accounts of the four small planets, the comets, and the variable star in *Ophiuchus*, by which Mr. Hind has rendered this small observatory so conspicuous in the astronomical world. The plan pursued by Mr. Bishop is one which must have led to success, maintained, as it has been, with steadiness and unity of purpose; and the results, striking as they may appear to us, are much more remarkable elsewhere. It is never related without a feeling of astonishment that the private observatory of a London manufacturer produces those results which nothing less than the power and means of governments can attempt in any other part of Europe. The Society may well offer its hearty congratulations to Mr. Bishop, and express its hope that his example may never want imitation, both in astronomy and in every other branch of knowledge.

It will be naturally expected that, in our report on the astro-

* "Ædes Hartwellianæ; or, Notices of the Manor and Mansion of Hartwell. By Capt. W. H. Smyth, R.N. London: Printed for Private Circulation." London, 1851. 4to.

nomical events of the past year, some mention should be made of the great solar eclipse which occurred in July last. We feel it incumbent on us, in the first place, to offer something like an apology for the delay which has occurred in the publication of the observations of that phenomenon which have been presented to this Society. But, in fact, the best apology which the Committee, appointed to examine the observations and to decide upon the mode of publication of them, can give to the meeting is the large mass of matter which has been presented to them for scrutiny, and the necessity for caution in the analysis and publication of the materials collected for explanation of the wonderful phenomena which have been witnessed in the course of the eclipse. We may state that the greater part of the labour has been satisfactorily accomplished; the cuts are in the hands of the engraver; the printing is going on; and the members will soon be put in possession of the results of all the observations which have reached the Society. The *Monthly Notice* for January last contains an abstract of the purely astronomical matter.

In the few remarks which we feel it proper to make on the general results of the observations of foreign and English observers, we cannot avoid mention of the number and completeness of the expeditions which were despatched from our own shores and from various parts of the continents of Europe and America, for the purpose of observing the eclipse. Private individuals and public establishments have vied with each other in their zeal for extracting from this rare phenomenon all the information which it can afford of the constitution of the sun and moon, and for determining on more certain data some of those vexed questions which observations of former total eclipses left for astronomers to settle. Some idea may be formed of the number of observers by the fact that the *Astronomische Nachrichten* contains at least sixteen accounts given by astronomers of reputation placed at different stations on the line of totality; our own transactions will contain at least an equal number; and there are still distinct accounts to be added, such as those of Mr. Carrington, Mr. Adie, and Dr. Von Feilitsch, which have been published in separate pamphlets.

The objects of inquiry were very distinctly stated in the "Suggestions" circulated previously to the eclipse. Neglecting the purely optical and meteorological questions which were to be answered, the points of general interest related to the phenomena of Baily's beads; the corona or ring of faint light always seen in a total eclipse; and the nature and origin of the rose-coloured prominences which had been seen during the eclipse of 1842, and, though not so distinctly, in some previous eclipses. With regard to the *beads*, which were, on the whole, considered to be an optical phenomenon, and probably connected with "irradiation," the object was to try the effect under as many different circumstances as possible, and with as many different telescopes: with regard to the *corona*, it was asked whether it was concentric with and had its origin in the sun or the moon; whether its light has any clear law

of diminution in going from the borders of the discs; whether it was fixed and steady or of an undulating character, with other particulars of the same general nature. Lastly, with regard to the red prominences, it was asked whether they belonged to the sun or the moon; and, supposing the former, whether they were solid bodies attached to his surface, or gaseous, cloud-like substances suspended in his exterior atmosphere and at ordinary times invisible.

Now, as we might have expected, some of these questions have been satisfactorily answered by means of the complete organisation of observers and instructions previously arranged; while others have been left unanswered, and, indeed, over some an additional degree of obscurity has been thrown by the knowledge we have acquired.

By comparing accounts of different observers, it would seem that the formation of the beads is dependent in a great degree on the telescope employed, since some observers saw no trace of them, while others saw them under that form in which they might easily be attributable to irradiation. Thus Mr. Airy and M. Mauvais saw nothing in the breaking up of the minute crescent of the sun's light but the interruptions caused by the plainly serrated limb of the moon. Mr. Hind had the same impression, but conceived that the effect was greatly heightened by irradiation, while Mr. Dawes saw them break through the crescent while it appeared to be considerably larger than their own projection beyond the moon's circumference, thus acquiring the appearance of narrow black threads extending to the exterior edge of the sun. The latter gentleman, from what he saw, seems to have no hesitation in referring the phenomenon to irradiation.

Thus, though the question of the beads does not yet seem to be quite settled, it is reduced within narrower limits, and Professor Powell's theory is, on the whole, confirmed by the observations.

The observations of the corona seem, on the whole, to prove that it belongs to the sun. Mr. Dawes thought he saw it both brightest and broadest at the part where the sun disappeared; and, throughout the duration of darkness, it was decidedly brighter at the southern edge of the moon than at the northern: these observations, considering his local position, are in accordance with the fact of the corona being concentric with the sun. Other observers could not at all determine whether it was concentric with the sun or with the moon. Other questions relating to the corona were satisfactorily answered; its light had a gradual diminution from the surface of the sun, and certainly did not consist of annuli of uniform brightness; large bushes or bands of light diverged at nearly equal intervals around the disc; finally, it was certainly strong enough to render it visible a very few seconds before the complete disappearance and after the first reappearance of the sun.

With regard to the red protuberances, the questions asked in the "Suggestions" have been many of them satisfactorily answered; the identity of several of them seen by different observers is un-

questionable; their positions on the limb are marked down with quite as great accuracy as could have been expected; and in general the drawings of their shapes agree pretty well. The northernmost observers saw protuberances on the northern limb hidden from those placed to the south of them, and those near the southern boundary saw protuberances hidden from more northerly observers. Again, it is most decisively proved from the observations that these wonderful phenomena belong to the sun: those that were observed on the eastern limb became quickly hidden, while others sprang up on the western limb; that is, they were respectively covered and revealed on the eastern and western limbs of the sun by the advancing moon. Those also that were *immediately* seen on the western limb increased in height during the totality. Finally, one at least was seen suspended, as it were, above the sun's disc, having no connexion whatever with the limb. Thus far the results of the observations were as satisfactory as could be desired, but there are discrepancies in the accounts concerning the most remarkable of the red prominences, which cannot be referred to error of observation, and which leave greater difficulty than ever concerning the true explanation of the phenomena. On the western limb was a remarkable red protuberance, which was considerably brighter than any of the others, and was itself attended by a small red mass not in contact with the limb. Now there are scarcely two observers who agree in their description of these: they differ in their accounts of the shape of the large protuberance, but still more in their description of the small one. Mr. Airy describes the large one as in shape like a bomerang, and in his drawing it consists of two arms very nearly at right angles to each other. Mr. Dawes is also very clear in his description of its shape and colour, and represents it as in shape resembling a Turkish cimeter, bent rather suddenly at the apex. Others describe it as of a sickle-shape, with the top broken off. The drawings differ quite as much as the verbal descriptions. The differences in the accounts of the accompanying mass are still greater. Mr. Airy saw it well defined at the borders, and in shape resembling a balloon. Mr. Dawes saw it like the top of a conical mountain, with its base cut off by mist. Others saw nothing but a spider-like irregular mass. Some saw distinctly arches of light, connecting it with the large prominence, which were not seen at all by others. Nor did these differences depend upon distance of locality. Lieut. Pettersson, located at two miles distance from Mr. Airy, differs considerably from Mr. Airy in his account. The appearances seen by MM. Lassell, Williams, and Stanistreet, who observed in the same house, are not the more accordant on that account. It seems, indeed, on the whole, impossible to reconcile the statements, without some hypothesis of *mirage*-effect, or other modifying cause, existing either in the neighbourhood of the moon, or in our own atmosphere.

Next to the large prominence, or perhaps superior to it in interest, are the deep red *sierras*, or jagged mountain-chains seen by

most of the observers, consisting of a succession of scarlet-coloured prominences, united at the base by a continuous red band. With regard to this phenomenon, Mr. Airy saw the most magnificent display of a probable effect of it. Along the north horizon, to about 30° or 35° of altitude, the sky was illuminated with rosy-red light for a breadth of about 90° in azimuth. At this time, the sierra which he saw in the telescope was far more brilliant in colour than any of the detached prominences; and it suggests the only probable or satisfactory explanation of the light.

On the whole, we may congratulate the Society on the success which attended the greater number of the observing expeditions;—many doubtful circumstances have been cleared up; and with regard to those which remain still perplexed and mysterious, we have data for the guidance of future inquirers, which will probably help at some future time to elicit materials for a far more minute acquaintance with the constitution of the sun than we at present possess.

At one of our late evening meetings, an instance was afforded of the aid which the art of drawing affords to practical astronomy, by the exhibition of a series of six large coloured landscapes by Professor Piazzi Smyth. These were drawn during the solar eclipse of last July, on the island of Bue on the coast of Norway, just within the band of totality.

In this instance the weather was adverse to astronomical observation; but the vicissitudes of the atmospherical effect during the progress of the phenomenon are very strikingly shown in the views which were exhibited, not only in the foreground, but also on the distant snow-capped mountains; and the very singular variations of sky, from the commencement of obscuration, through the totality, to the eclipse passing off, were faithfully represented. In these views, the peculiar streams, as it were, of clouds descending towards the sun, the dense crimson of one portion, the brilliant yellow of another, and the lurid aspect of the deepest darkness, offer much matter for physical inquiry.

Papers read before the Society from February 1851 *to February* 1852.

1851.

Mar. 14. Observations of Faye's Comet. Prof. Bond.
Ephemeris of *Egeria*. M. G. Rümker.
Observations of *Victoria*, &c. Mr. Carrington.
Elements of *Egeria*, and Notice of *Saturn*. Sig. Secchi.
Observations of *Victoria*. Mr. Hartnup.
Observations of *Victoria*. Mr. Graham.
Elements of *Victoria*. Dr. Gould.

Ephemeris of *Victoria*. M. Villarceau.
Graphical Solution of the Orbit of a Planet. M. Villarceau.
Notice of Lecture, Jan. 10, 1851. Sir J. Lubbock.
Observations of *Egeria*. Mr. Carrington.
Observations of *Metis*. Mr. Hartnup.
Ephemeris of *Egeria*. M. G. Rümker.
Observations of *Egeria*. M. C. Rümker.
On supposed Self-luminous Bodies. Mr. Jeans.
Azimuths on a Spheroid. Lieutenant Clarke.
On the Correction of the Altitude of the Pole Star. Mr. J. Riddle.
On the Parallax of α^1 and α^2 *Centauri*. Mr. Maclear.
On a Modification of the Quadrant. Mr. Hedgecock.
Observations of Small Planets. Mr. Hartnup.
Transits of Standard Stars. Rev. A. Weld.
Apr. 11. Note to *Monthly Notices*, Vol. ix. p. 184. Mr. Airy.
On Zodiacal Light. Mr. Lowe.
Note on his Drawing of *Saturn*. Rev. W. R. Dawes.
On the Correction of Lindenau's Elements of *Mars*. Mr. H. Breen.
On the Determination of the probable Stability of an Azimuthal Circle. Mr. Airy.
On the Elements of the Binary Star γ *Virginis*. Mr. Hind.
May 9. On the Vibration of a Free Pendulum in an Oval differing little from a Straight Line. Mr. Airy.
Elements and Ephemeris of Biela's Comet, 1852. Professor Santini.
Observations of *Metis*. Mr. Hartnup.
On the Use of the Gregorian Calendar for ascertaining New and Full Moon. Mr. De Morgan.
June 13. On the Discovery of *Irene*. Mr. Hind.
On a Solar Spot. Rev. A. Weld.
On the Nature of Solar Light. Mr. Nasmyth.
On the American Mode of Observing by the Galvanic Current. Mr. G. P. Bond.
Observations of *Irene*. Mr. Carrington.
Notice of Improvement in the Supports of Specula. Mr. Lassell.
Ephemeris of *Irene*. Mr. Pogson.
Observations of Faye's Comet and of *Irene*. Professor Challis.
Measurement of γ *Virginis*. Mr. Fletcher.
Occultation of Fixed Stars by *Jupiter*. Rev. W. R. Dawes.
Observations of *Irene* and *Astrea*. Mr. Hartnup.
Meridian Observations of *Irene*. Mr. Airy.
On M. Foucault's Pendulum Experiment. Mr. Drew.
Observations of *Jupiter's* Satellites. Mr. Moyes.
Observations of Minor Planets. Mr. Carrington.

Observations and Ephemeris of *Irene*, *Astrea*, &c. M. Rümker.
Elements of *Irene*. MM. Vogel and G. Rümker.
Remarks on Dr. Galle's Observations of Dark Ring of *Saturn*. Rev. W. R. Dawes.
On the Observation of Solar Spots with large Telescopes. Rev. W. R. Dawes.
On the Determination of a Meridian Point. Rev. A. Weld.
Observations of *Irene*. M. Rümker.
On the Discovery of *Irene*. Mr. Hind.
On the Solar Eclipse, Feb. 1, 1851. Mr. Clarke.

Nov. 14. Observations of *Irene*. Mr. Carrington.
Elements of *Irene*. M. Fergola.
Elements of *Irene*. Mr. Carrington.
Observations of *Hebe*. Mr. Carrington.
Observations of *Irene*. The Astronomer Royal.
Observations on Foucault's Pendulum Experiment. M. Secchi.
Elements and Ephemeris of *Irene*. Mr. Pogson.
Circular, D'Arrest's Comet. Dr. Petersen.
Observations of *Irene* and *Hebe*. Mr. Hartnup.
Ephemeris of *Parthenope*. M. Luther.
Observations of *Irene*. Mr. Boreham.
Observations of *Irene*. M. Rümker.
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Planetary Observations. M. Rümker.
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Observations and Elements of *Eunomia*. Dr. Petersen.
Discovery of Brorsen's Comet. Dr. Petersen.
Discovery of D'Arrest's Second Comet. Dr. Petersen.
Elements of D'Arrest's Second Comet. M. Vogel.
Elliptic Elements of D'Arrest's Second Comet. Mr. Pogson.
Moon-culminations at Hamburgh. M. Rümker.
Observations of *Hebe*. M. Rümker.
Observations, &c., of *Eunomia*. M. Rümker.
Elements and Ephemeris of *Irene*. M. G. Rümker.
Observations of *Jupiter* and his Satellites. Rev. J. Slatter.
Elements and Ephemeris of *Parthenope*. M. Luther.
Observations of Planets and Comets. Professor Challis.
Observations of Planets and Comets. Mr. Carrington.
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Planetary, &c., Observations. Mr. Hartnup.
Discovery of Satellites of *Uranus*. Mr. Lassell.

On an Improvement on the Quadrant. Mr. Hedgecock.
On the Solar Eclipse, Jan. 31, 1851. Capt. King.
Occultations, &c., and on the rule for equal Altitudes. Capt. Shadwell.
Ephemeris of *Parthenope*. MM. Luther and Vogel.
On Discordance of observed Places of Stars with B.A.C. Mr. Maclear.
De la Determination des Orbites Elliptiques. M. Valz.
On Hind's Third Planet. M. Villarceau.
Elliptic Elements of D'Arrest's Comet. The Astronomer Royal.
On the Rings of *Saturn*. Mr. De la Rue.
Observations of *Saturn*. Mr. Lassell.
On the Rings of *Saturn*. Mr. Fletcher.
On the Solar Spots. Mr. Miller.
On the Solar Spots. Capt. Shea.
On the Solar Eclipse, July 28, 1851. Mr. Snow.
Ditto ditto Mr. Lassell.
Ditto ditto Mr. Stanistreet.
Ditto ditto Mr. Williams.
Ditto ditto Mr. Miller.
Ditto ditto Rev. T. Chevallier.
On the Satellites of *Uranus*. Mr. Lassell.
On the Solar Eclipse, July 28, 1851. Rev. W. R. Dawes.
Dec. 12. On Luminous Bodies seen in Daylight. Rev. W. Read.
Cosmical Speculations. Mr. Dempster.
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Ephemeris of Brorsen's Comet, &c. M. Rümker.
Circular, Brorsen's Comet. Dr. Petersen.
Ephemeris of D'Arrest's Comet. Mr. Pogson.
Occultations of Stars. Mr. Snow.
Third List of Stars in B.A.C. Corrections in R.A. Lord Wrottesley.
On the Satellites of *Uranus*. Mr. Lassell.
Observations of *Saturn*, &c. Rev. W. R. Dawes.
Note on Mr. Slatter's Paper, No. 188. Rev. W. R. Dawes.
Solar Eclipse. Measurement of Solar Spots. Mr. Pogson.
Solar Eclipse, July 28, 1851. Mr. Hind.
Ditto ditto Professor C. P. Smyth.
Ditto ditto The Astronomer Royal.
Ditto ditto Mr. Dunkin.
Ditto ditto Mr. Humphreys.
Ditto ditto Capt. Biddulph.
Ditto ditto Capt. Blackwood.
Ditto ditto Mr. Gray.
Ditto ditto Lieut. Krag.
Ditto ditto Mr. Jackson.

Solar Eclipse, July 28, 1851. Colonel Silverstolpe.
Ditto ditto Mr. Stephenson.
Ditto ditto Lieut. Pettersson.
Ditto ditto Mr. Young.

On the Adjustment of a Transit Circle and an Equatoreal. Mr. Drew.

Observations of Solar Spots. Mr. Turnbull.

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Jan. 9. Notice of Rümker's Observations of De Gasparis' supposed Planet. Professor Challis.

Observations of *Parthenope*, *Pallas*, and *Victoria*. Mr. Carrington.

On De Gasparis' supposed Discovery of a new Planet. Dr. Petersen.

On the Markree Ecliptic Catalogue. Mr. Graham.

List of Public Institutions and of Persons who have contributed to the Society's Library, &c. since the last Anniversary.

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Address delivered by the President, J. C. Adams, Esq., M.A., Fellow and Tutor of St. John's College, Cambridge, on presenting the Gold Medal of the Society to M. Peters.

It has already been announced to you that the medal of the Society has been awarded to M. Peters, for his two papers, entitled, "Numerus Constans Nutationis ex Ascensionibus Rectis Stellæ Polaris in Specula Dorpatensi Annis 1822 ad 1838 observatis deductus," and "Recherches sur la Parallaxe des Etoiles Fixes," which are published respectively in the third and fifth volumes of the sixth series of the *Mathematical and Physical Transactions of the Imperial Academy of Sciences of St. Petersburg;* and it is now my duty to explain to you the grounds of this award, which (unless their effect be marred by my very imperfect statement of them) will, I doubt not, secure your approval.

These papers form part of a series emanating from the astronomers of the Pulkowa Observatory, and having for their object the advancement of sidereal astronomy; first, by a new and more accurate determination of the elements which affect the apparent places of all the stars, such as precession, nutation, and aberration, and, secondly, by an examination of the peculiarities affecting individual stars, such as annual parallax and proper motion, by which alone we can gain a knowledge of the scale on which the visible universe is constructed, and of the arrangement in space and of the relative motions of the bodies of which it is composed.

These important objects have been steadily pursued at the Pulkowa Observatory, under the guiding mind of its illustrious director, with an energy and success which have placed that establishment in a position with respect to sidereal astronomy, similar to that which our own observatory of Greenwich occupies with respect to the observation of the moon.

The order of date, as well as the nature of the subjects treated of, leads me first to speak of M. Peters' paper on the constant of nutation. But before proceeding to give an account of the paper itself, it may not be out of place to advert rapidly to former researches respecting nutation.

When Newton traced the precession of the equinoxes to its cause in the attraction of the sun and moon on the protuberant equatoreal zone of the terrestrial spheroid, he perceived that the sun's action would likewise cause a nutation of the earth's axis, the period of which is half a year. He contents himself with remarking that this nutation can be scarcely sensible.

In the same way, of course, the moon's action produces a small nutation of which the period is half a month. Abstracting these nutations, the tendency of the sun's action is to make the pole of the equator move in a circular arc about the pole of the ecliptic;

and in a similar manner the moon's action tends to make the pole of the equator describe a circular arc about the pole of the moon's orbit for the time being. Now, as this latter pole moves in a circle about the pole of the ecliptic in a period of about nineteen years, it is easy to see that this will give rise to an inequality in the rate of precession, and to a change of the obliquity of the ecliptic, having the same period.

It is curious, however, that Newton does not allude at all to this, which constitutes by far the most important part of nutation; and this is the more remarkable, since the principles which he lays down in treating of precession are quite sufficient to obtain, by means of very simple geometrical reasoning, not only the law, but, very approximately, the coefficients of the inequalities in the precession and obliquity due to this cause.

The state of practical astronomy, however, in Newton's time, was not sufficiently advanced to induce him to enter more fully into this subject; and it was, consequently, reserved for the immortal discoverer of aberration to detect these motions of the earth's axis by means of his observations, and then to trace them to their true cause. While discussing the observations which led him to the discovery of aberration, Bradley noticed that the annual changes of declination of the stars did not exactly correspond with those which would be occasioned by precession, and he made allowance for this by employing in the reduction of his observations the changes deduced from the observations themselves.

No sooner, therefore, had Bradley determined the law and the cause of aberration, than a new subject of investigation presented itself, requiring a much longer course of observations for its complete examination. Comparing his observations of different stars, he found that their changes of declination were such as might be attributed to a real motion of the earth's axis, and he was not slow in perceiving that the varying action of the moon upon the equatoreal parts of the earth, according to the different positions of the nodes of the lunar orbit, was the probable cause of this motion. During the course of the observations, Bradley communicated what he had observed to Machin, who was then "employed in considering the theory of gravity and its consequences with regard to the celestial motions," mentioning at the same time what he suspected to be the cause of these phenomena.

Machin confirmed this supposition, and showed that the observed motions might be very nearly accounted for, by supposing that the pole of the equator described a small circle about its mean position as centre, during a period of the moon's nodes.

Bradley remarked that his observations would be more completely represented by supposing the true pole to move about the mean pole in an ellipse instead of in a circle, the major axis being in the solstitial colure; and this conclusion is perfectly true, the minor axis being, however, a little smaller than he made it.

Bradley continued the observations during an entire revolution of the moon's nodes, and then published an account of his discovery

in the *Philosophical Transactions for* 1748, in a paper which is a perfect model of lucid statement and strict inductive reasoning.

In the following year, D'Alembert succeeded in determining the true motion of the earth's axis by means of analysis, in his "Recherches sur la Précession des Equinoxes et sur la Nutation de l'Axe de la Terre," and since that time the subject has been repeatedly treated of by physical astronomers. The most complete and elegant theoretical investigation, however, of the motion of the earth about its centre of gravity is that given by Poisson in the seventh volume of the *Mémoires de l'Institut.* The theoretical investigations with respect to nutation leave nothing to be determined by observation, except the value of one constant. This is generally chosen to be the coefficient of the principal inequality in the obliquity of the ecliptic. The accurate determination of this constant is important, not only from its being required for the reduction of star observations, but also from its affording one of the best means we have of determining the mass of the moon.

In precession we see the effect of the joint action of the sun and moon, but by means of the observed quantity of nutation, we can ascertain what part of this is due to the moon's action, and having thus obtained the ratio between the actions of the sun and moon, the moon's mass easily follows.

The most trustworthy determinations of the constant of nutation, previous to this of M. Peters, are those of MM. Von Lindenau, Brinkley, Robinson, and Busch; and M. Peters begins his memoir with a critical examination of their labours.

The results of the three latter astronomers present an admirable agreement, while that of Von Lindenau differs from them by about a quarter of a second. Von Lindenau employed about 800 observations of right ascension of *Polaris*, made at different observatories, and therefore his result is liable to be vitiated by the different personal equations of the several observers. We shall find in the sequel that this remark is important.

Brinkley deduced his value of the constant from 1618 observations of ten stars made about the times of two opposite maxima of nutation in declination with the Dublin meridian circle, the proper motions of the stars being determined by the comparison of his own declinations with those in the *Fundamenta.* As these observations embrace only half a period of the moon's nodes, the result is liable to be affected by errors in the supposed proper motions.

Dr. Robinson's investigation is contained in the eleventh volume of the *Memoirs* of the Royal Astronomical Society. He employs the declinations of the polar star, and of fourteen others observed at Greenwich between the years 1812 and 1835 with Troughton's mural circle. There can be no doubt of the high value of this investigation, but M. Peters thinks that, in consequence of the way in which the error of collimation is determined, errors of observation may exist with a yearly period, and that these may slightly affect the resulting value of nutation. Baily's coefficient of aberration is

employed, the annual parallaxes of the stars are neglected, and the equations of condition are not treated by the method of least squares.

M. Busch has deduced the constant of nutation from Bradley's observations at Kew and Wansted. The reductions are made in the most strict manner, except that the annual parallaxes are neglected, and M. Peters regards the result as worthy of the highest confidence.

M. Peters then enters upon his own investigations, which are based on 603 right ascensions of *Polaris*, observed at Dorpat between 1822 and 1838, with Reichenbach and Ertel's meridian circle. Of these observations, the first 249 were made by M. Struve, and the remaining 354 by M. Preuss. These are compared with the right ascensions deduced from the *Tabulæ Regiomontanæ*, and the equations of condition thence arising are treated by the method of least squares, taking as the unknown quantities the correction of the constant of nutation, the correction of the constant of aberration, the annual parallax, the corrections for the position of the axis of the transit-circle (illuminated pivot east or west), the correction of the star's right ascension, and the personal equation of the two observers.

The equations are first solved, giving equal weight to all the observations. The observations are then divided into two groups (one for each observer), and the equations of each group are solved separately. There is a surprising agreement between the results found from the four years' observations of M. Struve, and the twelve years' observations of M. Preuss, the coefficients of nutation deduced differing by less than three-hundredths of a second. This investigation supplies a measure of the precision of the separate observations, and it is found that M. Struve's observations are entitled to greater weight than those of M. Preuss.

The whole of the observations are then combined, giving the proper relative weights just obtained, and the equations are re-solved. The values found for the unknown quantities differ extremely little from the results given by the supposition of equal weights.

One of the most striking results is the constant difference between the right ascension given by the two observers, or the personal equation, which amounts, for *Polaris*, to more than 0·8 of a second of time. The magnitude of this shows that the personal equation changes with the declination of the stars. Hence, also, we may easily understand that M. Lindenau's results may be vitiated by the omission of the consideration of personal equation, especially as the observations which he employed were made with different instruments, as well as by different observers.

While M. Peters was employed in these investigations, M. Lundahl was likewise engaged in discussing the observations of declination of the same star, made also at Dorpat within the same space of time. The value of the constant of nutation which he deduces agrees admirably with those found by MM. Peters and Busch.

Finally, M. Peters takes the mean of the three results, giving

the proper relative weights to the several determinations, and he finds the most probable value of the constant to be 9″·2231 with the probable error 0″·0154. This value differs very little from Brinkley's, which has generally been employed by English astronomers, but M. Peters' determination undoubtedly possesses much greater weight.

M. Peters next enters upon a theoretical investigation of nutation, far more complete than any that had before appeared. Starting from the equations of Poisson's theory, he developes them, taking into account the ellipticities of the orbits of the earth and moon, and also the principal lunar inequalities. He thus obtains a great number of small terms which had previously been neglected. Most of these may be safely omitted; but there are two terms which should be taken into account in delicate investigations, as they have an annual period, and are therefore mixed up with the effect of aberration and parallax. M. Peters takes care to apply the requisite corrections to the coefficients of aberration, and to the parallax of *Polaris* given by his investigations. Although most of the new terms found by M. Peters are very small, yet these researches are not the less valuable, since it is always satisfactory to know what we really neglect.

M. Peters takes into account the effect of a possible difference between the ellipticities of the two hemispheres, which he determines by means of the pendulum experiments collected by Mr. Baily in his "Report on the experiments made by Foster," in the seventh volume of the *Memoirs* of the Royal Astronomical Society. It fortunately happens that this effect is insensible, as this difference of the two hemispheres is extremely doubtful.

The last part of M. Peters' paper contains researches on the obliquity of the ecliptic and the precession of the equinoxes, so that he treats of all the elements which relate to the apparent changes in the places of the stars, due to the motion of the pole of the earth. He deduces the secular diminution of the obliquity of the ecliptic by comparing the obliquity for 1757, given by Bradley's observations, with that for 1825 given by the observations of Dorpat, both being reduced to the mean by the new value of nutation. The rate of the diminution so found agrees very well with that found by M. Le Verrier from theory, the difference not amounting to one second in a century. The true value of the obliquity of the ecliptic at a given epoch cannot, however, be considered as definitively settled, in consequence of the puzzling constant differences between the declinations determined at different observatories. For instance, the obliquity given by the mean of several years' observations at Greenwich exceeds by rather more than one second the obliquity for the same epoch given by M. Peters' investigations.

M. Peters' researches respecting precession are based on the results of M. Otto Struve's paper, which obtained our medal on a former occasion, combined with M. Le Verrier's determination of the secular change in the position of the ecliptic.

M. Otto Struve determines, independently, by observation, the

values of two constants on which the precessions in right ascension and declination depend. Now, theory establishes a relation between these constants, and M. Peters is thereby enabled to find the most probable values which result from the combination of the observed values, and thence to derive complete formulæ for precession applicable to any given epoch.

I have no hesitation in regarding M. Peters' results, with respect both to precession and nutation, as definitive for the present state of astronomy.

I now come to M. Peters' second paper, which relates to the delicate subject of the parallax of the fixed stars.

The first part of this important paper contains an historical and critical review of the researches of astronomers respecting parallax from the time of Tycho to the year 1842. The second treats of the parallaxes of several stars as determined by M. Peters' own observations, made at Pulkowa by means of the great vertical circle of Ertel. In the third part, the results of the two former are applied to determine the mean parallax of stars of the second magnitude.

The historical part is drawn up with great care, and contains many curious and interesting discussions on particular points. For instance, M. Peters shows that the coefficient of aberration may be obtained with great accuracy from Flamsteed's observations of the zenith distance of the pole-star. The probable error of a single observation is found to be only 6″, which gives a far higher idea of the accuracy of Flamsteed's observations than has been generally entertained. Bradley himself remarked, that Flamsteed's observations of the pole-star agreed with his theory of aberration.

The celebrated controversy between Brinkley and Pond is discussed at considerable length, and the labours of the latter astronomer are criticised with great severity. M. Peters considers that Brinkley was far superior to his opponent in his knowledge of the theory of his instruments and in the use of precautions to avoid error, though it is certain that Pond was the more correct in his conclusions respecting parallax.

The parallaxes determined by M. Struve at Dorpat, from 1818 to 1821, by means of observed differences of right ascension of circumpolar stars having nearly opposite right ascension, deservedly occupy a good deal of attention. The parallaxes thus found, though small, were almost all positive, and M. Peters confirms their reality by the following ingenious consideration. He shows that any diurnal variation of the instrument due to temperature will affect the coefficients of aberration and parallax in the same direction, and the former probably more than the latter. Now, the coefficient of aberration found from these observations is about 0″·08 less than the definitive value given by the Pulkowa observations, and it is therefore probable that M. Struve's parallaxes should be increased by a few hundredths of a second.

It is unnecessary for me to follow M. Peters in his account of Struve's micrometrical measurements of the parallax of *α Lyræ*, of Bessel's well-known observations of 61 *Cygni* with the heliometer,

and of the parallaxes of *α Centauri* and *Sirius*, as determined by MM. Henderson and Maclear at the Cape, as these have been fully discussed by Mr. Main in an able paper in the twelfth volume of our *Memoirs*. The Council is also indebted to Mr. Main for a careful report on M. Peters' paper, from which I have derived considerable assistance in drawing up my account of it.

The second, and most important, part of M. Peters' paper consists of an investigation of the parallaxes of eight stars, by means of observations of zenith distance made by M. Peters at Pulkowa, in 1842 and 1843, with Ertel's great vertical circle. The stars selected are *Polaris*, *Capella*, *ι Ursæ Majoris*, *Groombridge* 1830, *Arcturus*, *α Lyræ*, *α Cygni*, and 61 *Cygni*.

The utmost care is taken in the instrumental adjustments, in the equalisation of the interior and exterior temperatures, and in eliminating every imaginable source of error.

It would be impossible for me to convey an adequate idea to any one unacquainted with M. Peters' paper, of the numerous precautions used by him for this purpose. For instance, the observations are made by placing the wire very near the star and then waiting for the time when the star is exactly bisected by it. The large motions of the instrument are always made without touching either the telescope, or the divided circle, or the pieces carrying the microscopes. In making the double observation (face East and face West) the micrometer-screw is always turned finally in the same direction, the reading of the levels is always commenced at the same end of the scale (though they are protected from heat by glasses). The effect of flexure of the telescope-tube is eliminated by an important arrangement, by which the eye-piece and object-glass are capable of being fixed at pleasure at either end of the tube. This transposition was made after every eight complete observations of the sun.

At every observation the readings of the microscopes are taken for coincidence with both the preceding and succeeding divisions on the limb, and the utmost pains are employed to correct for any inequality in the micrometer-screw and for errors of division.

Again, in the reduction of the observations and the elimination of the unknown quantities, the same attention to minute accuracy is observable. Thus, small terms are introduced into the expressions for aberration and nutation which had hitherto been neglected, and an elaborate investigation is entered into respecting the proper motions of the stars observed. The unknown quantities to be determined are the correction to the assumed latitude, the flexure of the telescope tube, the correction of the thermometrical coefficient of refraction, the correction of the assumed mean declination, the annual parallax, and the correction of the coefficient of aberration. Of these, the first three are found by means of the observations of the pole-star. All the equations are solved by the method of least squares, and the greatest care is used in estimating the probable errors of all the results, whether arising from probable errors of observation or uncertainty in the elements employed in the calculation.

There are also discussions on some curious points, such as the effect of clouds on refraction, the possible variability of latitude, &c. The resulting values for parallax are all positive, with the exception of that of *α Cygni*, which comes out a minute negative quantity; this, of course, only indicates that the real parallax of that star is probably extremely small.

The constant of aberration obtained by taking the mean of the several results for the different stars is 20″·481, which differs only 0″·036 from the definitive value found by M. Struve. The smallness of this difference gives great confidence as to the accuracy of the results for parallax, as there is no reason why the aberration should be found more accurately than the parallax.

Another strong confirmation is afforded by the fact, that the parallax of 61 *Cygni* determined by M. Peters is absolutely identical with that found by Bessel by means of the heliometer.

The last part of M. Peters' paper treats of the mean value of the parallax of stars of the second magnitude. M. Peters finds that there are thirty-five stars whose parallaxes are determined with sufficient accuracy to serve as a basis in this research. Of these, however, he excludes two stars which have very large proper motions, 61 *Cygni* and 1830 *Groombridge*, as exceptional, and therefore not properly to be included when an average is the quantity sought. Struve's scale of relative distances of stars of different magnitudes is employed in combining the observed parallaxes for different stars, although the final result is nearly independent of the assumed scale, inasmuch as the second magnitude is nearly the mean of all the magnitudes of the stars employed.

M. Peters shows his usual skill in estimating the probable errors which may arise from the defects of the hypotheses employed, such as that of the same absolute brightness of the stars, as well as from the errors of the observed parallaxes; and he finally arrives at the result, that the most probable value of the mean parallax of stars of the second magnitude is 0″·116, and that the probable error of this determination is only 0″·014.

M. Peters closes his paper with a most interesting result deduced by combining his own researches with those of M. Otto Struve respecting the solar motion. M. Otto Struve finds that the annual apparent motion of the sun, as seen at right angles from a point at the mean distance of stars of the first magnitude, is 0″·339. Now, according to M. Peters, the mean parallax of a star of the first magnitude is 0″·209; so that we are able to turn the former result into absolute measure. Thus the annual motion of the sun with respect to the great body of the surrounding stars is equal to 1·623 times the radius of the earth's orbit.

I cannot but regard this work of M. Peters as a perfect model of excellence, evincing consummate skill in the observer, as well as admirable power of turning the observations to the best account. It shows that it is possible by meridional observations to obtain absolute parallaxes almost as small as the relative parallaxes that can be measured by the heliometer or by similar means; though to do

so requires a most rare union of instrumental advantages, care and judgment in the observer, and analytical skill in combining in the best manner the results of observation.

No one can read the papers of M. Peters, or those of the Russian and German astronomers generally, without being struck with the constant employment of the method of least squares. It is to be wished that this method were more in use among English astronomers, as I believe not a little of the precision of modern determinations is due to it. We seem to entertain a distrust respecting the results of the calculus of probabilities, more particularly with regard to the estimation which it affords of the probable amount of error in any determination.

It should be borne in mind, that when we speak of the probable error being of a certain amount, it is not meant that it is improbable that the error should exceed that amount, but only that it is as probable *à priori* that the error falls short of, as that it exceeds it. If we know by independent means that the error of any determination is much greater than the probable error given by the observations, we may infer, with great probability, that some constant cause of error has occurred in the observations employed. In the estimation of probable error, only fortuitous causes of error are taken into account. The employment of the method of least squares does not render it less necessary to avoid all sources of constant error: it is not a substitute for, but an auxiliary to good observations, and enables us to obtain from them all that they are capable of yielding.

I cannot conclude without congratulating the Society on the improved prospects of that very delicate branch of astronomy which relates to the research of stellar parallax, especially as there is every reason to believe that this country will contribute its full share to the advancement of it. We may hope that the beautiful reflex zenith telescope of the Astronomer Royal, the magnificent heliometer which is in the able hands of Mr. Johnson, and the improved method of recording star transits by means of galvanism, will enable us ere long to take many firm, though long-reaching, steps into regions of space hitherto untrodden.

(*The President then, delivering the Medal to Mr. Hind, Foreign Secretary, addressed him in the following terms*):—

In transmitting this medal to M. Peters, you will assure him of our high appreciation of the importance of the results at which he has arrived, and of the admirable science and skill which he has shown in obtaining them; and you will express our confident hope that in his new sphere at Konigsberg, he will confirm and add to the reputation which he has so deservedly acquired at the observatory of Pulkowa.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year, when the following Fellows were elected :—

President :

J. C. Adams, Esq. M.A. F.R.S.

Vice-Presidents :

G. B. Airy, Esq. M.A. F.R.S. Astronomer Royal.
Rev. George Fisher, M.A. F.R.S.
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Treasurer :

George Bishop, Esq. F.R.S.

Secretaries :

Augustus De Morgan, Esq.
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